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Secrets of Automobile Casting Manufacture

How One Foundry Attained Success in this Difficult Branch of Gray Iron Work by the Application of Common-Sense Methods

"Dan" Ryan
"The Man Behind"

OWING to the heavy demand and the high prices prevailing, castings for automobiles and motor trucks have tempted many foundrymen to engage in this branch of foundry work. The requirements of the builders of self-propelled vehicles seem to be almost unlimited and contracts customarily are placed for thousands of cast parts. The apparent ease with which this business can be obtained has been and still is the bait which leads many foundrymen to bid for this work, regardless of their experience or the shop equipment necessary for its production. Yet many contracts, obtained at exceedingly favorable figures, have netted heavy losses. This is attributed to the intricate design of automobile castings and the severe requirements of the trade, and unless a shop is specially-equipped throughout for this class of work, the high prices paid per pound will prove insufficient to cover the cost of manufacture.

Intricacy of design, thinness of section and multiplicity of cored parts

FIG. 1—GENERAL VIEW OF A FLOOR OF FOUR-CYLINDER CRANK CASE AND FLYWHEEL HOUSING MOLDS

FIG 2—COPE PATTERN DRAWN FROM FOUR-CYLINDER, CRANK CASE AND FLYWHEEL HOUSING MOLD

FIG. 3—COPE HALF OF THE MOLD LIFTED OFF BY TRAVELING CRANE

FIG. 4—SIX-CYLINDER CRANK CASE AND FLYWHEEL HOUSING PATTERN MOUNTED ON JAR-RAMMING, ROLL-OVER AND PATTERN-DRAWING MACHINE

FIG. 5—A FLOOR OF 33 FOUR-CYLINDER CRANK CASE AND FLYWHEEL HOUSING MOLDS

FIG. 6—DRAG HALVES OF FOUR-CYLINDER CRANK CASE AND FLYWHEEL HOUSING MOLDS

characterize practically all castings used in automobiles and motor trucks. Automobile engineering practice shows no tendency toward simplified design and many of the new models are more intricate than those that preceded them. To produce these castings satisfactorily requires not only a wide knowledge of this practice, but also necessitates the employment of the proper equipment to facilitate the production of the cores and molds. Foundries specializing in this work more nearly approach the modern machine shop in refinement of practice, than any other casting shops. As the cores must be set with great precision, straight edges, templets and gages are used extensively and the core boxes are machined to hundredths of an inch to insure accuracy of size. The metal is another factor of importance which must receive careful consideration. Clean castings are essential and the metal must be sufficiently fluid to rapidly fill the mold. As the service to which the castings are subjected is severe, strength and wearing qualities are essential and the mixture must be made to insure these various properties in the metal.

New Specialty Shop

In recent years numerous shops have been built in the Cleveland and Detroit districts for the manufacture of castings for the automobile trade. The latest addition to this list of specialty plants is the gray iron foundry of the Allyne-Ryan Foundry Co., Cleveland. The promoters of this enterprise all had considerable previous experience in the production of castings for the automobile trade and their combined knowledge of the requirements of this line of manufacture is reflected in the completeness of the equipment of this shop. While it is customary to estimate an average loss of 15 per cent on cylinders, crank cases and similar work, the losses of this plant since it was placed in operation six months ago have not exceeded 10 per cent. The latter include return scrap, rejected castings and general foundry discard. On some castings the losses have averaged not more than 3 per cent.

In the production of the molds, machines play an important part, and every pattern is mounted for molding machine operations. It is estimated that an order for 100 duplicate castings warrants the mounting of a pattern on a molding machine and as contracts frequently are placed for thousands of duplicate parts, the economy of machine operation can be appreciated. Special cast iron flasks are used throughout and these are designed to provide for the minimum amount of sand between the flask and the pattern. Skim gates are used on all the molds and frequently, in addition to the skimming core in the sprue, skim gates are provided at the joint of a mold where the gate diverges into a number of runners. Metal boxes are used for making the cores and dryers are employed to

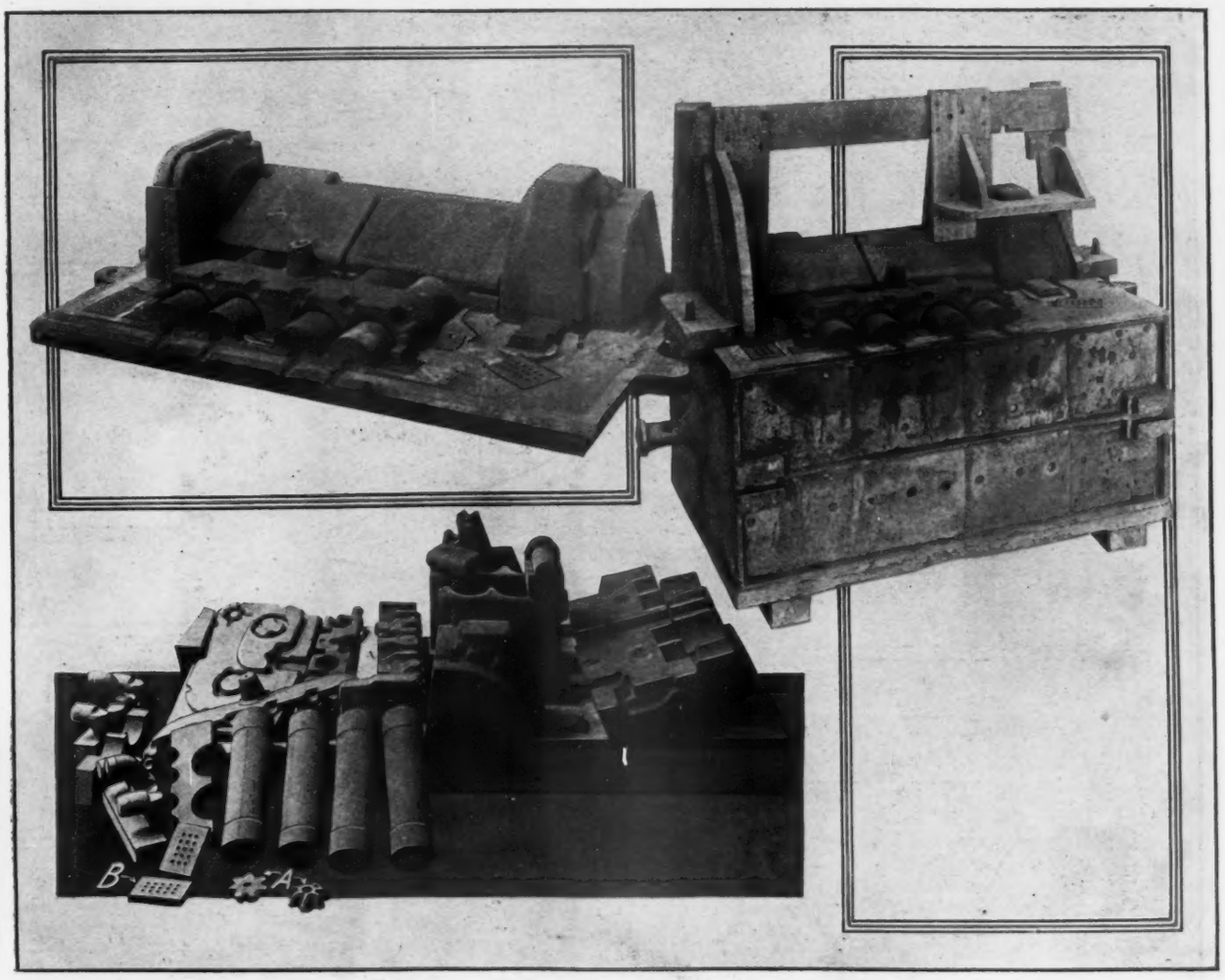


FIG. 7—DRAG HALF OF MOLD CORED FIG. 8—TRYING THE CORES WITH A TEMPLET
FIG. 9—PATTERN PLATE, MOLD AND DUMMY

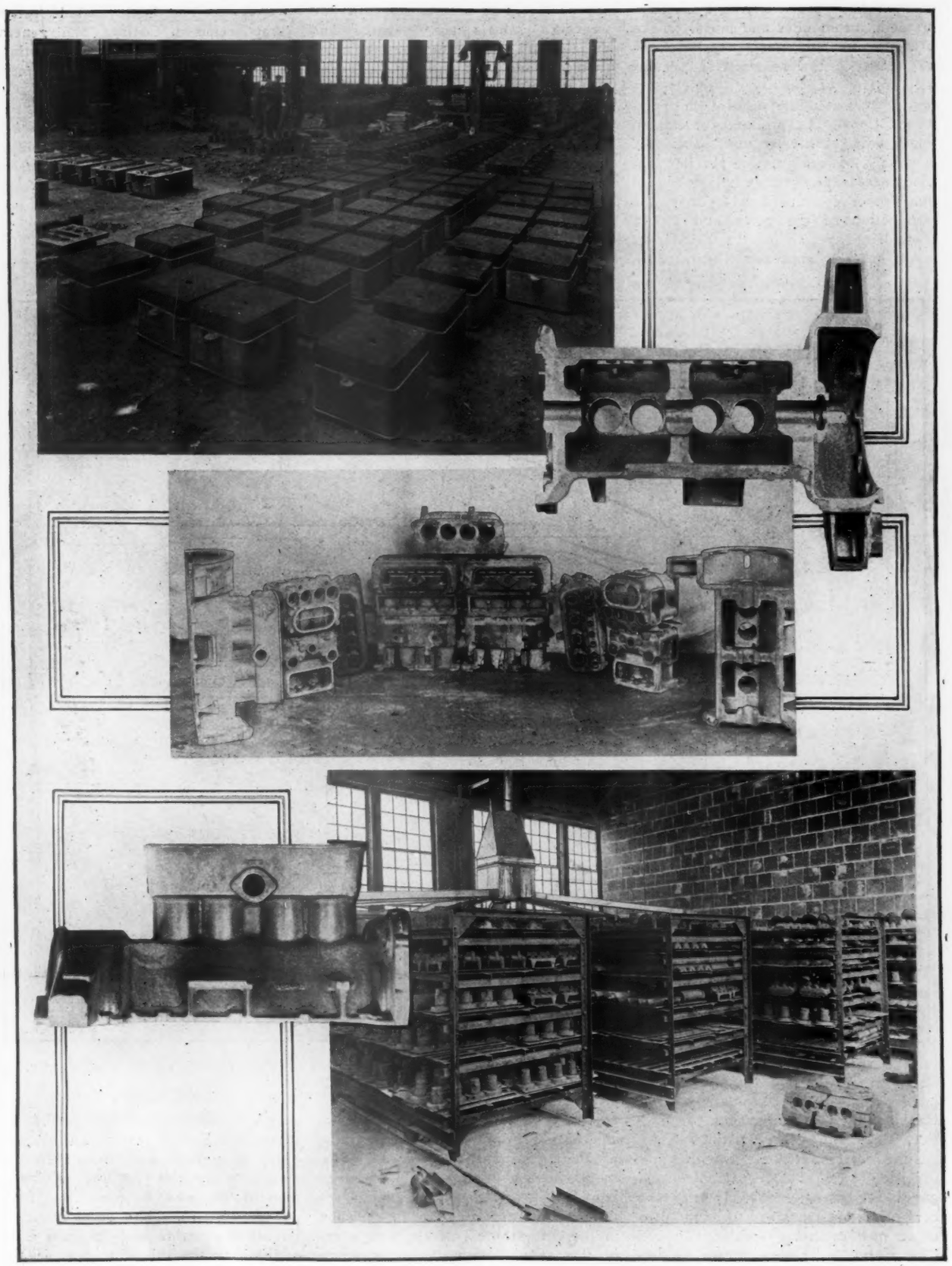


FIG. 10—FLOORS OF PISTON AND TWIN-CYLINDER MOLDS

FIG. 11—INSIDE VIEW OF FOUR-CYLINDER CRANK CASE AND FLYWHEEL HOUSING CASTING

FIG. 12—A MISCELLANEOUS ASSORTMENT OF AUTOMOBILE AND MOTOR TRUCK CYLINDER CASTINGS

FIG. 13—OUTSIDE VIEW OF CASTING, FIG. 11

FIG. 14—A BATTERY OF FOUR CORE OVENS, SHOWING LOADED CARS

prevent the distortion of the cores while in the ovens. Every operation in the manufacture of these castings has been carefully studied for the purpose, not only of facilitating production, but also to insure a quality product with a minimum loss.

One of the largest and most intricate castings for a self-propelled vehicle that has been made at the Allyne-Ryan foundry is a four-cylinder crank case and fly-wheel housing, cast in one piece. This casting is for the power plant of a motor truck and reflects the tendency in motor vehicle engineering practice toward more involved designs than have maintained heretofore. An inside view of one of these castings is shown in Fig. 11 and Fig. 13 is the outside. The metal thickness of the crank case and water jacket is only 5/32 inch and the cylinders are bored to ¼ inch.

The pattern is mounted on a jar-ramming, roll-over, pattern-drawing machine, two of which have been installed by the Osborn Mfg. Co., Cleveland. The molds are made by a crew of seven men and 33 molds constitute a day's output. With the aid of the machine one mold is finished in 15 minutes. When made by hand, one mold was a day's work for a molder whose sand was cut by a laborer, and the output of the machine and its crew of seven men per day is equal to the production of 33 molders and four laborers operating by hand. The molding machine crew consists of five molders and two helpers; one of the helpers shovels the sand into the electrically-operated riddle while the other fills the flasks; two molders are employed in making the drags and copes, two set cores and one molder is required for finishing the molds.

The jar-ramming, roll-over, pattern-drawing machine on which these molds are made, is shown in Figs. 2 and 3. The cope pattern is mounted on the pattern plate, and in these views, the mold has been rolled over and the pattern drawn. When making a mold, the flask is set over the pattern, filled with sand and the mold is rammed on the table of the jar-ramming machine. The bottom or cope board then is clamped to the flask, the mold is rolled over and is deposited on a carriage operating on a track which extends a short distance beyond the end of the machine. After leveling the mold, the vibrator is operated and the pattern is drawn by the upward

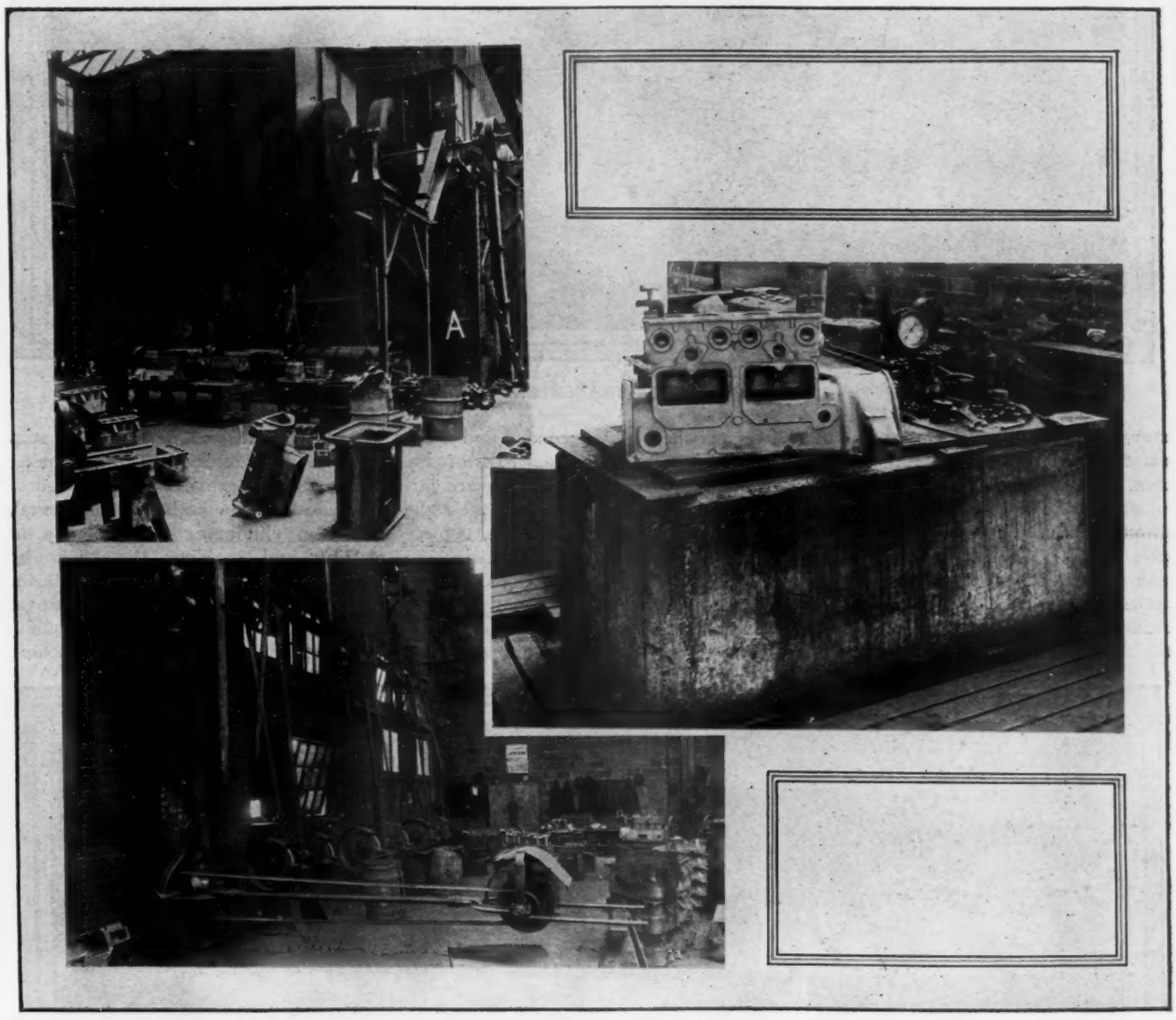


FIG. 15—THE CLEANING ROOM, SHOWING TUMBLING MILLS, DUST ARRESTERS AND SAND BLAST
FIG. 16—THE GRINDERS

FIG. 17—THE HYDRAULIC CYLINDER CASTING TESTING BENCH

FIG. 18—A FLOOR OF TRANSMISSION CASE MOLDS

movement of the side supports of the pattern frame. After drawing the pattern, the carriage supporting the mold is drawn forward in position to be lifted off. In the meantime the pattern plate is swung back into position on the jar-ramming table to make another mold. All of the operations, with the exception of filling the flasks and moving the carriage are accomplished by compressed air. When making the cope half of the mold, the two pouring basins are jar-rammed over the sprues and after the removal of the basin patterns, a piece of burlap, slightly larger than the flask, is laid over the mold to prevent sand from falling into the sprues and risers while rolling over. This burlap is clearly shown on the cope board in Fig. 3 and also can be seen in Fig. 2. The method of ramming the pouring basins not only insures a smooth, clean well for the metal, but also eliminates the necessity of cutting and molding the basin by hand. In Fig. 3 the cope is shown slightly tilted prior to its removal from the carriage.

The molds made on this machine

FIG. 19—MACHINE EQUIPMENT FOR MOLDING TWIN-CYLINDERS

FIG. 20—A FLOOR OF TWIN-CYLINDER MOLDS

are lifted off by an overhead traveling crane, the crane hook supporting a bail which engages the flask trunnions. The crew operating this machine begins work at 6 a. m., 33 drags first being made. Then the drag is replaced by the cope pattern. This method of procedure gives the core setters an opportunity to place the cores in a number of drags before operations on the copes have been commenced. A floor of these molds as it appeared at 9 a. m. on the day when the views accompanying this article were made, is shown in Fig. 1. It will be noted that the cores in practically two-thirds of the drags have been set and a number of the molds have been closed. A floor of 33 molds, clamped and ready to pour, is shown in Fig. 5. The molding machine crew usually completes its floor at about 2 p. m., and the molds are poured by a gang of laborers.

The drag half of this mold is illustrated in Fig. 6. A noteworthy feature of this work is the fact that all of the molds, including every intricate job in the shop, are made in green sand, none being dried. This

FIG. 21—A FLOOR OF FOUR-CYLINDER MOLDS

FIG. 22—EQUIPMENT FOR MOLDING PISTONS

explodes another theory that it is impossible to obtain smooth castings for automobile work except when poured in dry sand molds. The flasks in which these large motor truck molds are made are 22 x 38 inches and 17 inches deep, both cope and drag being the same size. The parting surfaces of the flasks have been accurately machined to insure a close joint and thereby eliminate fins. Four recesses, *A*, Fig. 6, are cut into the parting surface of either side of the flask at the center of each of the four barrel cores and serve as vents for the gases generated in these comparatively large, dry sand parts.

A total of 28 cores is placed in each drag, a complete set being shown in Fig. 9. The large cores at the right form the crank case and the small cores on top of the crank case cores form the crank case bearing. The four barrel cores are in the foreground and the water jacket cores, end core for the crank case and the port cores are in back of the barrel

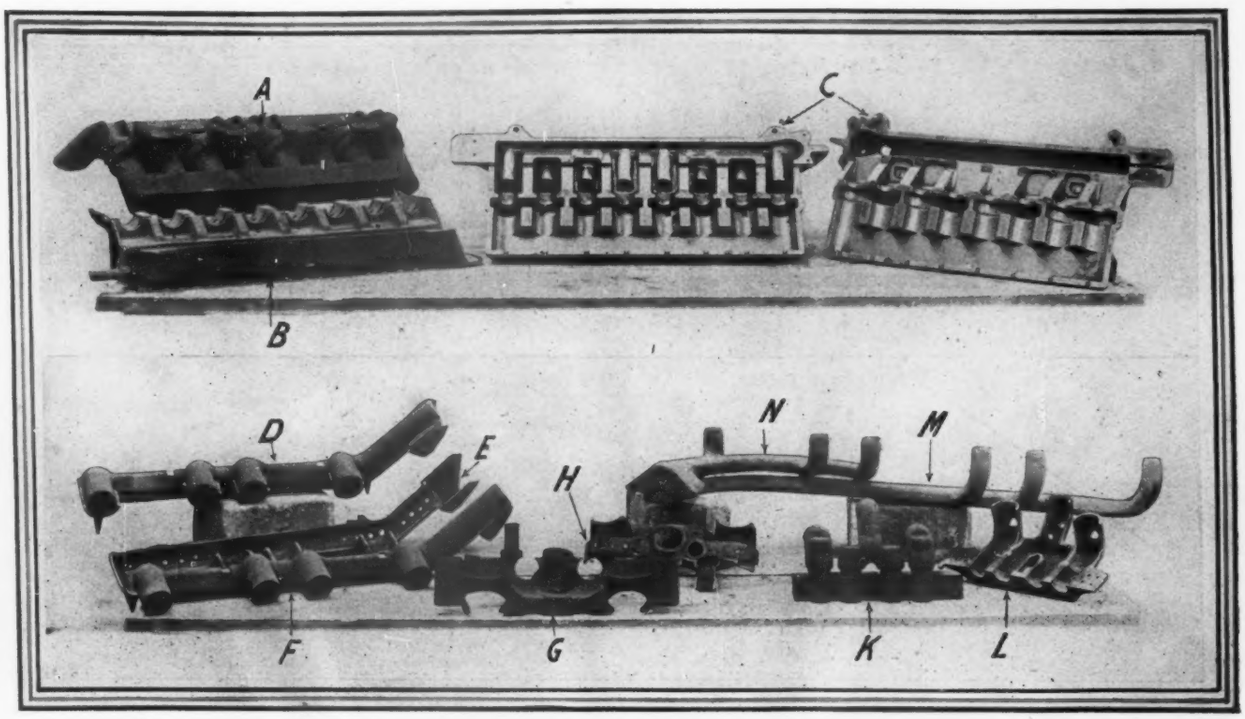


FIG. 23—MISCELLANEOUS INTRICATE CORES, CORE BOX AND DRYERS

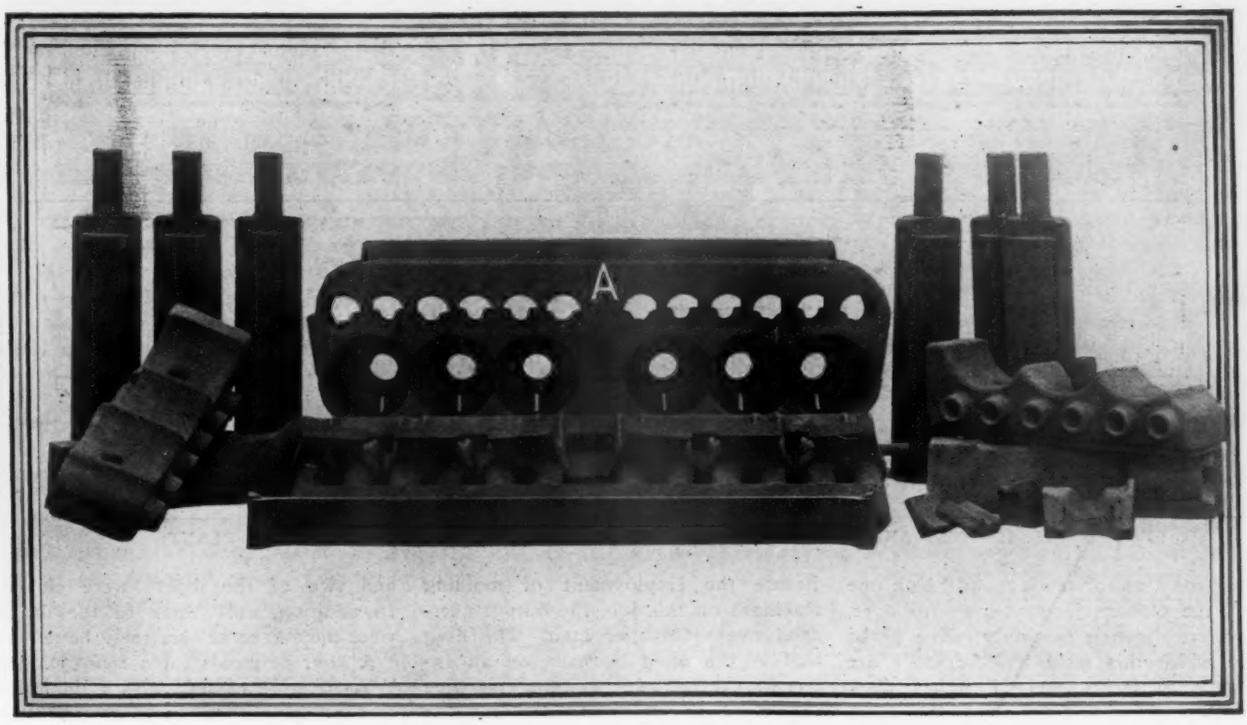


FIG. 24—SET OF CORES FOR A SIX-CYLINDER CASTING

cores. The two skim gates set into the sprues are illustrated at *A*, and *B* shows two additional skim gates set into the drag at the parting line. These are clearly shown in Figs. 7 and 8.

Setting the cores requires considerable skill and templets, straight edges and gages are used to insure their accurate location. A mold completely cored and ready to close is shown in Fig. 7. However, before the core setter proceeds with the work on another drag, a templet is tried over the cores as shown in Fig. 8. Pins on the parting line of the templet engage the flask pin openings and accurately locate the templet. If the latter binds, rubs or cannot be lowered into position, it is an indication that the cores have not been properly set and the mold is not closed until the trouble has been remedied. This is one of the many precautions that accompanies all of the operations in this foundry and which reduces casting losses and results in a high grade product. Fig. 4 shows an aluminum pattern for a combined six-cylinder crank case and flywheel hous-

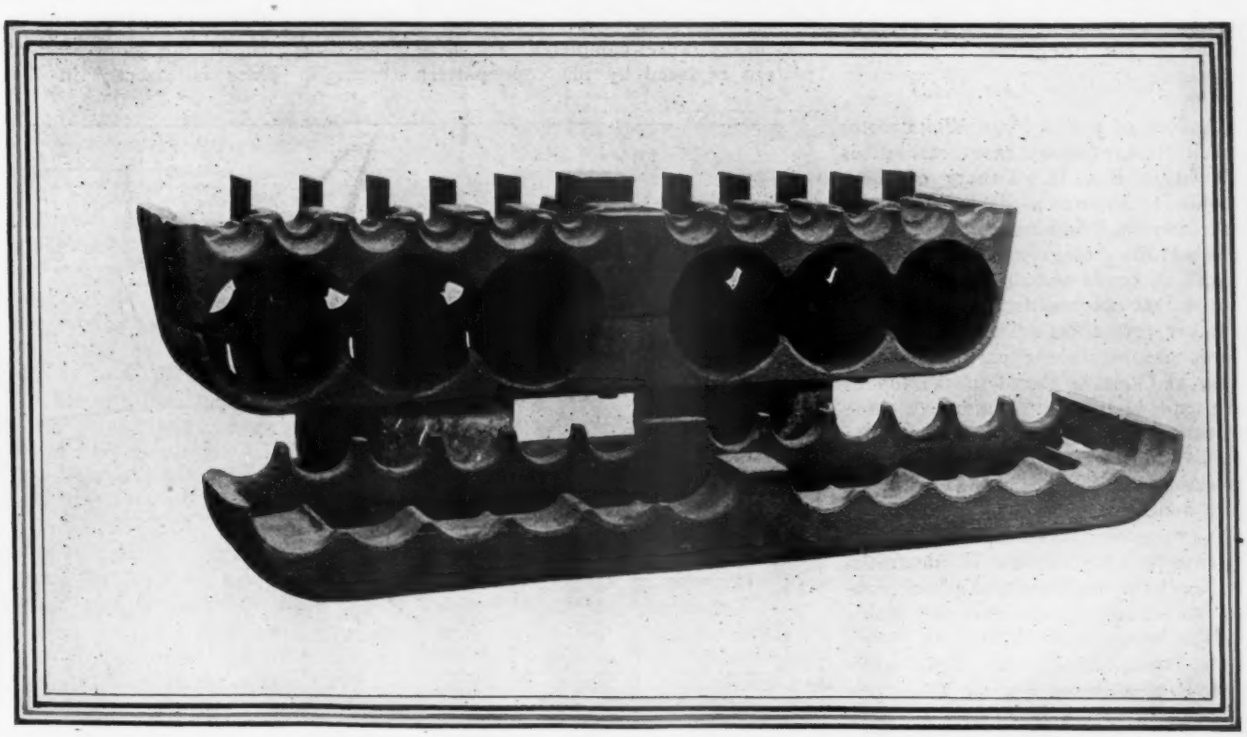


FIG. 25—SIX-CYLINDER WATER JACKET CORE WITH TOP REMOVED

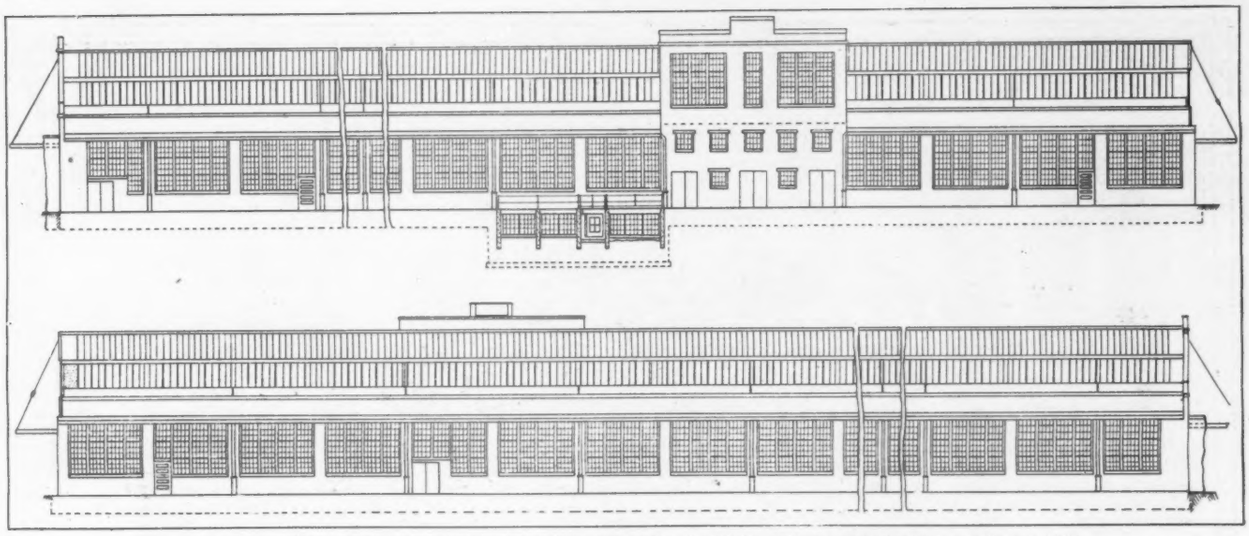


FIG. 26—WEST AND EAST ELEVATIONS OF THE ALLYNE-RYAN FOUNDRY CO.'S PLANT

ing for a motor truck mounted on one of the Osborn jar-ramming, roll-over, pattern-drawing machines. The flasks in which this mold will be made are 22 x 50 inches and 17 inches deep, both cope and drag being the same size. The metal thickness of the crank case and the water jacket is only 5/32 inch, while the cylinders are ¼ inch thick. As this mold is considerably larger than the combined four-cylinder crank case and flywheel housing, the daily output for a seven-man crew has been fixed at 20. The mold carriage of the large Osborn machine is clearly shown in Fig. 4. The four equalizer posts for leveling the mold are locked in position simultaneously by the lever extending beyond the frame of the machine in the foreground.

Transmission Case Molds

A floor of molds for a White motor truck transmission case casting is shown in Fig. 18. Twenty of these molds constitute a day's work for two men, a Pridmore roll-over molding machine being employed for making both copes and drags. It will be noted that the molds require a large number of cores. Two skim gate cores are set in the parting of each drag and one is placed in the top of the main body core. The use of these skim gates insures clean metal in the molds and practically eliminates the rejection of castings as a result of dirt and slag holes.

A pair of machines for molding a twin-cylinder casting is illustrated in Fig. 19, and a part of the floor consisting of the three rows of molds in the background of Fig. 10, shows about one-third of the day's work completed at about 9 a. m. The crew consists of two molders and a helper and their daily output is 70 molds. Before the employment of molding machines on this job, the output averaged five molds per man. The drag half of the mold is made on an International roll-over molding machine shown at the left, and the cope is molded on an Osborn stripping plate machine. The helper sets the cores, aids in lifting off and closes the molds. A drag with the cores set ready for closing is shown at the left, Fig. 19.

Another twin-cylinder floor is illustrated in Fig. 20. Two operators on a Pridmore roll-over machine produce 25 molds daily, whereas by hand, four molds per man constituted a day's output. The photograph from which Fig. 20 was made, was taken at 10:10 a. m., and it will be noted that all of the drags were completed, the drag pattern replaced by the cope pattern and two of the molds were closed. In addition, only three of the drags were uncovered at this early hour.

A floor of molds for a four-cylinder White engine casting with a manifold cast-in, is shown in Fig. 21. The molds are made on a pair of International roll-over molding machines, the one at the left being equipped with the drag pattern, while the cope pattern is mounted on the machine at the right. Nine of these molds constitute a day's work for two operators as compared with four by two men when molding by hand. It will be noted that the mold is cored throughout and four skim gates are set in the parting of each drag.

An Osborn piston molding machine is illustrated at the right, Fig. 22, and the drag half of the mold with the cores in place is directly in front

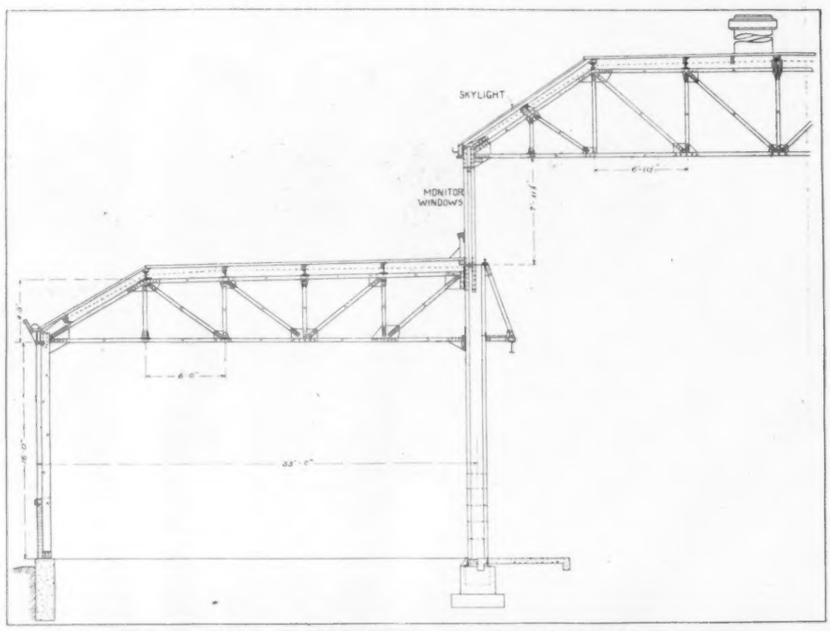


FIG. 27—HALF CROSS-SECTION OF THE FOUNDRY BUILDING

of the machine. In the foreground is shown a number of skim gate cores, one of which is set at the bottom of the sprue in each mold. At the left is shown the bench on which the copes are rammed on an iron cope pattern plate containing the sprue in the center. The cope serves merely as a covering and is made in a snap flask. The daily output of two men is 125 molds containing four pistons each or a total of 500 pistons. When made by hand, the output of two men was 200 pistons. Each mold contains 38 pounds of metal and the entire floor aggregates 4,750 pounds. This is an enormous output and greatly exceeds the average production for a pair of operators on comparatively light work.

The Osborn piston machine is of the jar-ramming, roll-over, pattern-drawing type, and aside from filling the flask with sand, practically all of the operations are mechanically performed. In the foreground of Fig. 10, 49 piston molds are shown, which constituted the output of the two operators at 10:15 a. m. Flywheels are molded on a pair of International roll-over and stripping plate machines. The output of a molder and helper is 100 molds per day containing from 80 to 100 pounds of metal each. A number of squeezers also have been installed for small work, which include six Osborn, two Adams and two Berkshire machines.

Intricate Cores

In the production of these castings, a large amount of intricate core work is involved. As previously stated, practically all of the cores are made in metal boxes and cast iron dryers are provided to prevent the distortion of the irregularly-shaped cores in the ovens. A number of intricate cores, with their metal boxes and dryers are illustrated in Fig. 23; *A* is the core for a White four-cylinder engine casting and *B* is the dryer; the two halves of the metal core box in which this core is made are shown at *C*; the cost of this core box was approximately $150, yet notwithstanding the expense of this equipment the accuracy of the cores made and the facility with which they can be produced has more than compensated for this outlay.

At *D*, Fig. 23, is shown a four-cylinder manifold core on its dryer; *E* is the cast iron dryer and *F* is the core; the bottom half of a water jacket core is illustrated at *G* and *H* is the dryer for this core. A more intricate core would be difficult to design, yet it is made in one piece and the use of the dryer prevents the heavy losses which would result from warping if no dryer were used; *K* is one section of a four-cylinder port core and its dryer is shown at *L*. Another example of the automobile engineer's intricacy of design is indicated by the core *M*. This is a core for a new type of exhaust manifold with the baffle plate, ⅛ inch thick, cast between the two parts of the cores, *N* and *M*. The upper core, *N*, is dovetailed to the lower core, *M*, and is merely supported at one end.

Core for Six-Cylinder Casting

The cores for a six-cylinder automobile engine casting are shown in Fig. 24. The six barrel cores are in the background at the left and the right, and the exhaust core, made in one piece, is in the middle foreground. The water jacket core, which is made in three pieces, is shown at *A*. In Fig. 25 the top has been removed from the water jacket core and is shown in the foreground. The middle section of this core contains 10 small water inlet cores which are pasted in position after this section of the core has been baked.

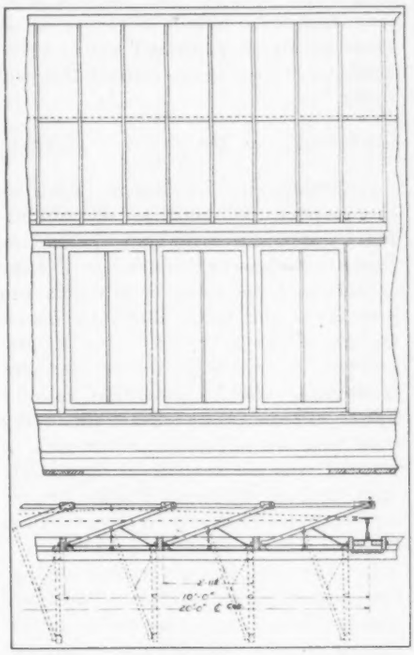


FIG. 28—SECTION AND ELEVATION OF MONITOR WINDOWS

The core department occupies one end of the foundry and is equipped with a battery of four car type ovens, Fig. 14, fired with natural gas and installed by the Core Oven Equipment Co., New Haven, Conn. This illustration shows the four core cars just before unloading in the morning and clearly indicates the miscellaneous, irregularly-shaped cores required in the manufacture of automobile and motor truck castings. On the opposite side of the core shop four drawer type ovens and a double car oven, built by the J. D. Smith Foundry Supply Co., Cleveland, have been installed. These ovens are coke-fired.

The castings are cleaned in a room, 60 x 70 feet, partitioned off from the foundry by a fire wall. Both the sand-blast and tumbling processes of cleaning are employed, the mill equipment consisting of eight small and one large barrel. The sand blast room, shown at *A*, Fig. 15, is entirely enclosed with steel plates, the front door being counterweighted. The sand, after use, is exhausted from the room and is delivered to a hopper where the fine dust is separated from the particles that can be used again. The dust arrester for the tumbling mills is clearly shown and three spouts are provided for the discharge of the dust from the arrester hoppers. This entire equipment, including the tumbling barrels, sand blast and dust arrester, was installed by the W. W. Sly Mfg. Co., Cleveland. Arranged along the front walls of the cleaning room are three double grinding stands and swinging grinder, as illustrated in Fig. 16.

Testing the Cylinders

To reduce to the minimum the number of returned cylinders from customers, all of these are hydraulically-tested for leaks. They are subjected to 100 pounds pressure and if a leak develops the casting is scrapped. This test is particularly severe inasmuch as the cylinders are subjected to not more than six pounds pressure in service. The hydraulic testing bench with a four-cylinder crank case and flywheel housing mounted for a test, is shown in Fig. 17, and gives another view of the casting, made on one of the large Osborn jar-ramming, roll-over, pattern-drawing molding machines. An assortment of cylinder castings after testing, is shown in Fig. 12. These sections clearly illustrate the variety of design of several automobile and motor truck builders.

Practically 80 per cent of the metal melted is semi-steel, varying in steel content from 10 to 20 per cent. All of the various mixtures for pistons, small and large cylinders and miscellaneous work are melted in one heat by varying the charges. For comparatively small cylinders and light work a 10 per cent semi-steel mixture is used and for large cylinders, 20 per cent steel is added to the charge. The cupola, which is of the Whiting type, has a 78-inch shell and is lined to 64 inches. Bottom is dropped no

(*Continued on page 275*)

Uniform Cost Methods in the Foundry Industry

Valuable Suggestions for the Elimination of Cut-Throat Prices—Why Some Foundrymen Lose Money and the Remedy

By C E Knoeppel

I DO NOT believe I will be accused of exaggeration when I state there is no line of work which calls for more effort, with less in the way of profits, than the jobbing foundry industry. Every locality has its jobbing foundries. The competition is intense. All do everything in their power to get their share of the business, at prices that will yield a fair margin of profit, yet when the statements for the year are studied, there is a feeling of disappointment over the showing. My work to date has brought me in contact with 30 distinct lines of endeavor and it is surprising to what extent those engaged in competitive lines have complained about their results. Professional ethics forbids my outlining specific instances, but the facts I have gathered are sufficient to warrant a careful analysis of underlying reasons.

Foundry Bugaboos

I found this recently in one of our trade papers, under the heading "Some Foundry Bugaboos":

"The surgeon, for instance, certainly ought to be satisfied with his job. When he wants an extra five hundred, all he needs to do is to single out one of his well-nourished patrons, prod him viciously just below the first floating rib until he grunts and then utter those three magic (likewise remunerative) words—'appendicitis, operation imperative'. This is effective salesmanship. Could any manufacturer land a contract with such dispatch? Hardly.

"Which is quite different from the manufacturing business. If a manufacturer wants to squeeze out an extra $25, he will have to spend a couple of weeks with his cost cards, and figures, and sweat and snort and chew his nails way up to the knuckle, and finally when he does locate a twenty-five that he might possibly grab if he slips up to it quietly and it does not happen to see him first, along comes an unexpected bill for something or other and gobbles it up."

Some years ago THE FOUNDRY made this statement in one of its editorials—

"Figures compiled by a jobbing foundryman, statistically inclined and located in a leading iron and steel center, indicate that the business in which he is engaged is an exceedingly precarious one. During the past eight years he has kept a record of failures as well as the number of concerns that have engaged in this line of work, but have discontinued for various reasons. The figures are startling as they show that no less than 47 gray iron foundries within a radius of 10 miles of his shop, passed out of existence, 46 remaining to contest the field today."

Importance of the Foundry Industry

According to the census statistics the foundry and machine shop industry, compared with all industries, ranks second as to the number of wage earners and the value of products and first as to the value added by manufacture. Why is it then that so important an industry should be confronted by such a condition as outlined? There is a reason for every condition, no matter how complex, if we will take the trouble to investigate in a careful manner. Further, every fault can be bettered to some extent at least.

Let us, therefore, briefly analyze the industry from its competitive standpoint. There are three fundamental truths which stand out so prominently as to hardly admit of an argument:

1. Every manufacturer who furnished a product of good quality and can make reasonable deliveries, is entitled to his share of the available work at a fair and reasonable margin of profit.
2. Any concern which purchases a product below the cost of production, is enjoying something to which it is not entitled and really belongs to the manufacturers of the particular product.
3. Price is subject to scientific laws.

A manufacturer writes you that he is in the market for castings; he furnishes prints and specifications; you carefully canvas the situation and make a bid on the work. Later you call upon the manufacturer and he tells you that he would like to give you the order, but informs you that your price is too high and unless you can give him a better price, he will be forced to give his contract to another. You reconsider the quotation carefully and finally make him a better price. Perhaps you get the order and perhaps you don't—it all depends upon the number of bidders in the field. Further, the manufacturer no doubt advanced the same argument to all who bid on his work. It is often done. He fully realizes, and is secure in his belief, that each one is in ignorance of the prices quoted by the other, and on general principles is in a position to say he has an even better price than the lowest quoted. The result is that you are not only bidding against the others who are after the same work, but worst of all, you are bidding against yourself. Your own doubts and fears, your immediate necessities are the only factors which determine how much you will shave the price. Consequently, instead of one of you being benefited by the transaction, the third party is the one who walks off with the gains.

Recently I was told of a case where a concern contracted to furnish castings at $2.85 per 100 pounds. When it was apparent that money was being lost somewhere, an investigation was made with the result that the actual cost of this particular work was found to be between $4 and $5 per 100 pounds.

Results of Low Prices

This naturally brings up another point. Not only does the buyer profit to the extent of the difference between the cost to the foundryman and the price the buyer pays, but he will expect some other foundryman, when the present contract expires, to furnish him castings for a price not much in excess of $3 per 100 pounds. If he cannot get a quotation near this figure, and he can hardly be blamed under the circumstances for not wanting to pay $5 per 100 pounds, he will advertise his requirements generally until some foundryman who must have work at any figure, or who does not know his exact costs, will give him a bid that is satisfactory. As a result the honest and intelligent foundryman is working at a decided disadvantage. But was not some foundryman to blame in the first place?

In another foundry an insignificant little item was noticed, namely melting loss, 2.9 per cent. It was found

that the scales were giving the foundry the best of it for, as a matter of fact, the melting loss was nearer 7 per cent, the difference representing 66 tons in a year that the foundry did not make.

The reason we have combinations, monopolies and trusts is because competition became too merciless for comfort and success. Manufacturers realized that there was no sense in working against each other year after year to their own detriment and getting nowhere, when by joining forces they could prosper. In industries where each knows about what the others are doing, prices are stable, and a concern hesitates a long while before deciding to cut prices, knowing that once a cut is started, no one can predict where it will end.

Since the establishment of the Interstate Commerce Commission, the situation regarding freight rates is infinitely better than when rebates and secret favors were the order. The steel trade has been much better because of its base and extra prices, which all mills practically maintain, than it was when purchasing agents all over the country were prone to wait until some mill salesman came along with a better price.

There is absolutely nothing in bidding against yourself even though in a competitive sense you are forced to bid against each other. Price is the all-important factor and everything which tends to regulate prices, eliminate secrecy and unfair dealing, is what you want—what you must have if you are to secure your share of the work at prices which will insure you a consistent profit.

Causes of Business Failures

If we eliminate such considerations as lack of capital, unwise credits, extravagance and fraud, there are four factors which, whether considered separately or in combination, can cause distress to an industrial concern:

1.—Too many concerns for the requirements.
2.—Lack of systematic methods.
3.—Failure to ascertain correct costs of production.
4.—Lack of uniformity when bidding on work.

Agreements as to price are a difficult thing to bring about. Further, they are likely to be declared illegal. A body of competitors once said, "We no sooner combine and agree upon a price than it is a race to the telephone to see who can book orders first at prices a little under those fixed."

My study of the subject leads to this conclusion: Agreement as to price is not necessary. The comparing of bids is not essential. Combination to control a local situation is not the solution. The vital consideration is this. Such uniformity in ascertaining and compiling costs and making estimates as to insure against wide difference in prices, in brief, a measure making possible stable prices without any general agreement or secret understanding.

Figuring Costs

I realize only too well the attitude of many manufacturers toward cost methods. There are a number of reasons for this. In many cases the accounting is a mere jumble of figures, which have little or no value as a guide to the executive. In others, vital information is only compiled once a year, or if an attempt is made to get at monthly results, the statements are furnished so long after the last of the month as to make them almost valueless. Then again, costing methods may furnish information without regard to the needs of the business, or they may be changed materially from time to time.

As a declaration of principles, let us decide first of all that a foundry costing arrangement to be efficient must consider the needs of the business in question; that it must be comprehensive, proceeding on the broad lines that information should be given an opportunity of working for the executive—not a burial which may have no resurrection; that it must be planned to make possible a rapid comparison and analysis of pertinent information; that it must be simple to admit of its being readily understood and quickly operated so that the facts can be furnished promptly; that it must be arranged so that unnecessary work and entries will be done away with, in addition to which it should be designed to furnish information during the month—a point of advantage to every manager.

Assume that six out of ten manufacturers should decide on uniform costing, and as a result have a scale of prices that would not vary to any great extent. It is evident that a manufacturer takes work below cost only because he is forced to, or because he is ignorant of his true conditions. The manufacturer who decides to play a lone hand, not having the intelligent basis to work on possessed by the others, would be bidding more or less in the dark and to his own detriment. In other words, if to the six foundries, the requirements called for a price of from $2.70 to $2.80 per 100 pounds, and one of the other four bid as low as $2.25, every one of the six can rest assured that the foundry in question is going to lose money. It is much better to have a smaller tonnage at consistent prices than to fill up on losing work, for if money is to be lost, let the other fellow do the losing. The result, however, can only be that sooner or later the four foundries will be forced to join the movement for uniformity or go out of business. There is always a limit to the amount a concern can lose.

Scientific pricemaking is a matter of accurate costs. If, therefore, as regards the majority of foundrymen who decide for uniform costs, one finds that he is consistently higher in his bidding, it can only mean one or both of two things:

1.—He is not operating efficiently.
2.—He is adding too much profit to his costs.

Because a proper costing arrangement enables a manufacturer to intelligently check up his weak spots, he can soon determine where the faults are and correct them. This will mean lower costs and as a result, a lower price at the same rate of profit he figured before. If, however, he finds no opportunity to reduce his costs, and this would be a rare case indeed, it means a reduction in the rate of profit until conditions are better. At any rate, uniformity in costing means intelligent competition, as well as furnishing a means for increasing operating efficiency. Many manufacturers have told me that they have no objection to competing with others when they knew that the others were operating intelligently and with full knowledge of their true condition.

In a brief way I will outline the requirements of a uniform system of foundry costs:

1.—Costs of labor and material should be accurately determined and properly classified.
2.—The expenses or burden should be carefully considered and so classified as to give the executive the opportunity of studying each element separately. Expenses are either legitimate or beyond reason, and it pays to know which.
3.—Apportionment of expenses to production must be arranged for on some basis as will not make the cost of heavy work too high nor the cost of light work too low, or the result will be lost sales on heavy work and plenty of light work at losing prices.
4.—Those who buy castings should pay most for that which costs the most to produce.
5.—Costs vary with productivity, by which is meant the relative amount produced per man per day. The work of a man producing a ton a day costs less per 100 pounds than that of the man who produces only 500 pounds, and the cost should reconcile these differences.

6.—Costs should be classified according to whatever plan will best meet the particular conditions found. This can be done by classes of work, kind of molding, separate patterns, classes of patterns, departments or by classes of weights.

7.—Costing should be placed on a 30-day basis, furnishing 12 opportunities per year for locating and correcting faulty conditions, and while not absolutely necessary, the costing can be made a part of the general accounting.

8.—Estimates can be based on standardized rates for the various costs which would enable a foundry to make prices based on current conditions.

Because each foundry would have in use its own particular system, and further, because each manager would have some ideas of his own as to the way costs should be determined, it would be necessary in arranging for the installation of uniform costing to briefly study the system in each plant, ascertain from the executive his particular viewpoint, and then draft a simple, but comprehensive plan that could be used by all, which, after being submitted to the concerns and a plan decided upon, could be installed simultaneously into the various plants. The old order of things is changing. The methods of yesterday are being discarded for betterments. Competition of the usual type is giving way to co-operation. Men are coming out in the open and dealing with each other on lines of justice and fairness. The plan of the past was for one concern after another to introduce more up-to-date methods without regard to what his neighbor did. The plan of the future is going to be the getting together of several and then arranging for the installation of methods that will mean uniformity, less cost of installation to each, and more in the way of results to all concerned.

Anvil Block Cast in Open Sand

By Louis Luhrsen

RECENTLY an anvil block in our blacksmith shop was broken and a new block had to be cast immediately. Owing to the weight of the casting and the inadequate crane facilities, the problem of handling the metal was considered first. The foundry contains only one hand-operated jib crane and two ladles of two and three tons capacity, respectively. A longitudinal section of the mold through the runner box and runner is shown in Fig. 1, and the division of the mold into two parts for pouring is illustrated in Fig. 2. The straight section of the casting from *A* to *B*, Fig. 2, was 22 inches in height and it was estimated that 3,600 pounds of iron would be required to fill this section of the mold. The upper part of the casting from *A* to *C*, was 14 inches high and required 5,200 pounds of metal. When pouring, it was decided to empty one ladle first, then set it down and pick up the other ladle. As the crane was operated by hand, a cessation of pouring of a considerable interval would occur between each ladle; consequently, it was possible that the metal might partially set and leave a seam at the juncture when pouring was resumed. The two-ton ladle was, therefore, poured first for the reason that it filled the straight part of the mold where the seam would not be so liable to form as on the curved section, which the metal would have reached if the large ladle had been poured first.

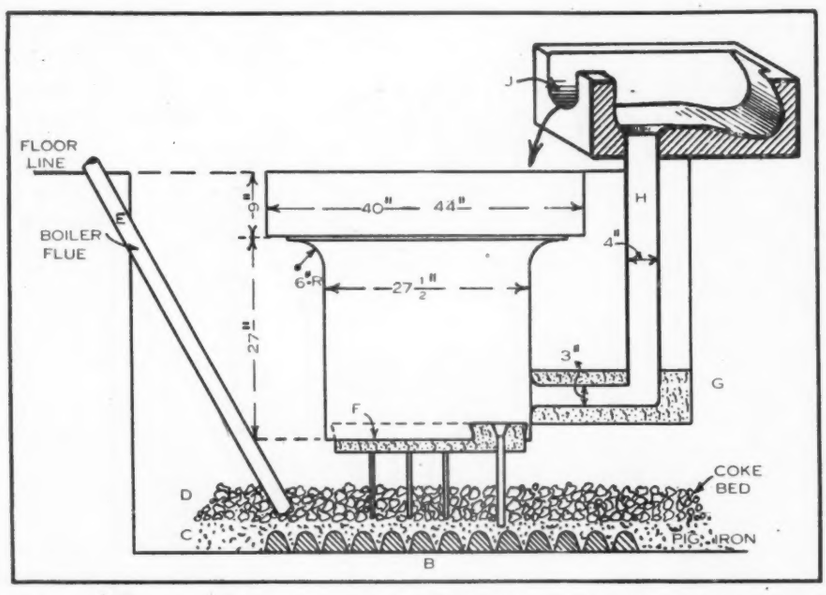


FIG. 1—POURING ARRANGEMENT OF A MOLD FOR POURING A LARGE ANVIL BLOCK

As the foundry floor was made of filled ground, and owing to the great mass of metal poured into the mold, it was decided to make the mold in a pit at the bottom of which a row of iron pigs was placed, as illustrated in Fig. 1. On top of the pigs a bed of sand was firmly rammed. A 4-inch coke bed was placed on top of the solid bottom formed by the pig iron and sand, and a 3-inch boiler flue was arranged to carry off the gases. On top of the coke, a bed of sand, 6 inches deep, was leveled, and upon this bed the pattern was placed for ramming. The casting was gated at the bottom, just above the dovetail core, *F*, which was made in two parts, thus forming a dry sand bottom for the mold. The horizontal part of the gate, from its juncture with the casting to the down gate, consisted of a core made in halves and pasted together, the top half having a round hole at the end remote from the casting, to admit the 4-inch down gate, in the manner shown in Fig. 1. The dovetail core was put in position and spiked down after the pattern was drawn, the print having been vented into the coke bed. The mold was faced with a sand composed of one part of sea coal and eight parts of sand, the latter having consisted of one part new and two parts old sand. The mold was coated with a good grade of silver lead which was thoroughly rubbed into the surface of the mold. The core mixture consisted of one part of linseed oil to 35 parts of sharp sand. The core received three coats of silver lead blacking, mixed with molasses water and applied uniformly. As the machine shop was not equipped to handle this casting on the planer, the cavity made by the core had to be accurate to admit the

steel die block used on the old anvil.

The runner box, it will be noted, was made with an open end, *J*, Fig. 1, the object of which was to throw a stream of iron, as indicated by the arrow, into the open mold to feed the casting. As a rule, the iron becomes sluggish as it approaches the top of a mold of this type, and as soon as this was noticed when this mold was cast, the metal was poured sufficiently strong to throw a stream of iron from the end of the runner box into the top of the mold. This stream cut the surface of slag on the metal in top of the mold and carried it upward which permitted easy skimming. Shortly after the casting was poured, a hole was broken through the crust in top of the metal and additional iron was poured into the mold until the crust was raised slightly; the casting was then covered with sand and was allowed to cool. The top was straight and required no machining.

In Fig. 3, an anvil block for a large steam hammer is shown, which was molded in a similar manner, except that the neck, which was 19 inches deep, was made in the core, *B*, as it was believed that the strain would be too great for a green sand mold. The seat for the steel die block was formed by the core, *A*, which was securely fastened to *B* by two ⅝-inch bolts. This arrangement made it impossible for the seating core to break away. The pattern, *D*, was only a shell, the neck of which rested in the core, *B*, as shown in Fig. 3. The mold, when finished, resembled the section shown in Fig. 1. The 4-inch gate was placed so that the iron would strike the middle of core *A*.

Secrets of Automobile Casting Manufacture

(*Continued from page* 271)

later than 5 p. m., and this arrangement has proved exceedingly satisfactory to the molders and machine operators.

The foundry is a brick and steel structure, 112 x 280 feet, and is divided into three bays, two 33 feet wide and the center bay, 46 feet wide. The side bays are 21 feet, 6 inches high and the monitor over the middle bay is 36 feet above the level of the floor. As shown in the elevation, Fig. 26, the window and skylight area is unusually large and affords ample natural light. The middle bay of the foundry is commanded by a 10-ton traveling crane and the iron is delivered to the various floors by an overhead trolley. A half cross-section of the building showing the monitor construction is shown in Fig. 27. In a basement underneath the foundry is a fireproof pattern storage vault, 32 x 40 feet. A pattern shop also is operated, which is mainly devoted to the preparation of patterns for mounting on molding machines, the manufacture of core boxes, dryers, etc. The plant was designed and built under the supervision of the Forest City Engineering Co., Cleveland.

The monitor sash, shown in Fig. 28, are vertically hinged and are hung from the jambs, the same as a door. The sash can be opened 90 degrees from the building, giving 100 per cent ventilation. The monitor windows are operated from the floor by a worm and gear and they are so counterweighted that opening and closing are easily effected. The sash are hung in sections, one for each bay. One section of the monitor windows is operated in one direction and the next section in the opposite direction. This sash requires practically no alignment, nor are shaft and shaft hangers employed. This system of operating vertically-hinged sash was installed by the Forest City Engineering Co.

D. J. Ryan, president and general manager of the Allyne-Ryan Foundry Co., formerly was general superintendent of the Interstate Foundry Co., Cleveland. M. J. Sweeney is secretary and treasurer and J. F. Sords, general superintendent.

Hill & Griffith Co.

The Hill & Griffith Co., Cincinnati, with branches at Birmingham and Pittsburgh, recently has installed considerable new machinery in its various plants and also has added a testing laboratory for testing all of its manufactured products, which is under the direction of F. W. Weissmann, who has had a wide experience in chemistry as applied to the foundry trade and who is vice president of the American Chemical Society. The officers of the Hill & Griffith Co. follow: D. T. Richards, president and treasurer; William Oberhelman, vice president; C. A. Truesdale, secretary, and J. M. Glass, sales manager.

A small plant will be erected at Arnold, near New Kensington, Pa., by the Aluminum Company of America for the manufacture of aluminum foil. This material will be produced in a rolling mill which is the first of its kind to be built in the United States.

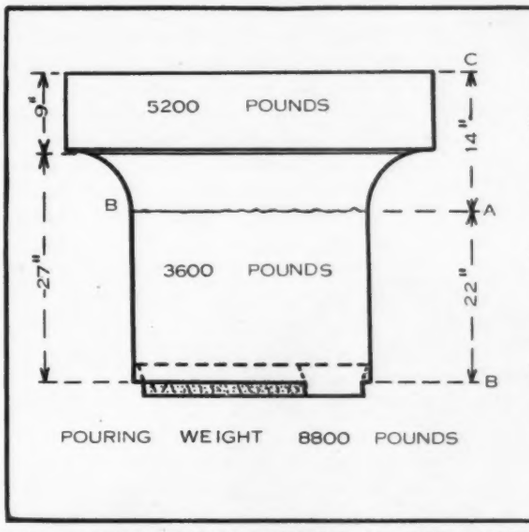


FIG. 2—THEORETICAL DIVISION OF THE MOLD FOR POURING

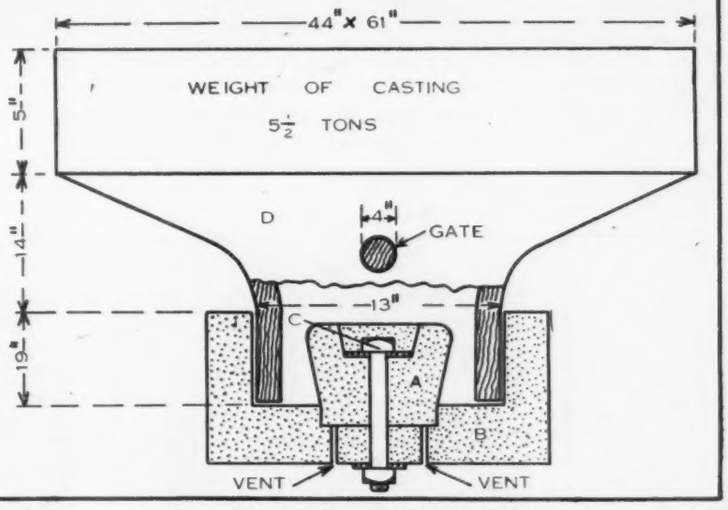


FIG. 3—SECTIONAL VIEW OF ANOTHER ANVIL BLOCK MOLD

Malleable Iron Castings for Automobile Work*

A Discussion of the Thickness of Section That Can Be Annealed, the Limit of Silicon Content and the Strength and Adaptability of Malleable

By Enrique Touceda

ALTHOUGH malleable iron, as compared with steel, enters into automobile construction to a limited extent only, the actual amount used in the industry is large. I believe it will be admitted, as a general proposition, that the constructing engineer, while thoroughly posted on carbon and alloy steels, knows less about this material than possibly any other passing through his hands.

There is a widely prevalent misconception that when any part of a malleable casting exceeds ⅜ inch in thickness of section, the change that normally takes place during the annealing process, whereby the hard and brittle white iron castings that come from the air furnace are converted into soft, tough and ductile ones, is but imperfectly accomplished.

The malleable iron process is conducted in two steps, the first of which consists of melting gray pig iron upon the hearth of an air furnace, when a certain amount of the original silicon, carbon and manganese is oxidized, and thus removed from the iron while it is being melted and subsequently raised high enough in temperature to successfully run the castings. The following three facts are well known to those who possess even an elementary knowledge of the metallurgy of iron and steel:

First, most of the carbon content of gray pig iron exists in the form of graphite, that is, free; if a pig be broken and the fractured end be gone over with a stiff brush, it is easy to thus remove the exposed little flakes of graphite held in mechanical mixture with the iron and always separated from the iron during and for an interval after solidification.

Second, when pig iron is uniformly white in fracture, no graphite is apparent upon inspection; instead of the carbon separating out in whole or in part as graphite, it is all combined with the iron *chemically*.

Third, a pig iron having most of its carbon in the form of graphite, can be changed into an iron in which none of its carbon will separate out as graphite if this pig iron be melted in such a manner that a certain amount of its silicon content be removed from it through oxidation; for if the silicon content is in excess of a certain amount, it prevents the carbon from combining

*Presented at the summer meeting of the Society of Automobile Engineers.

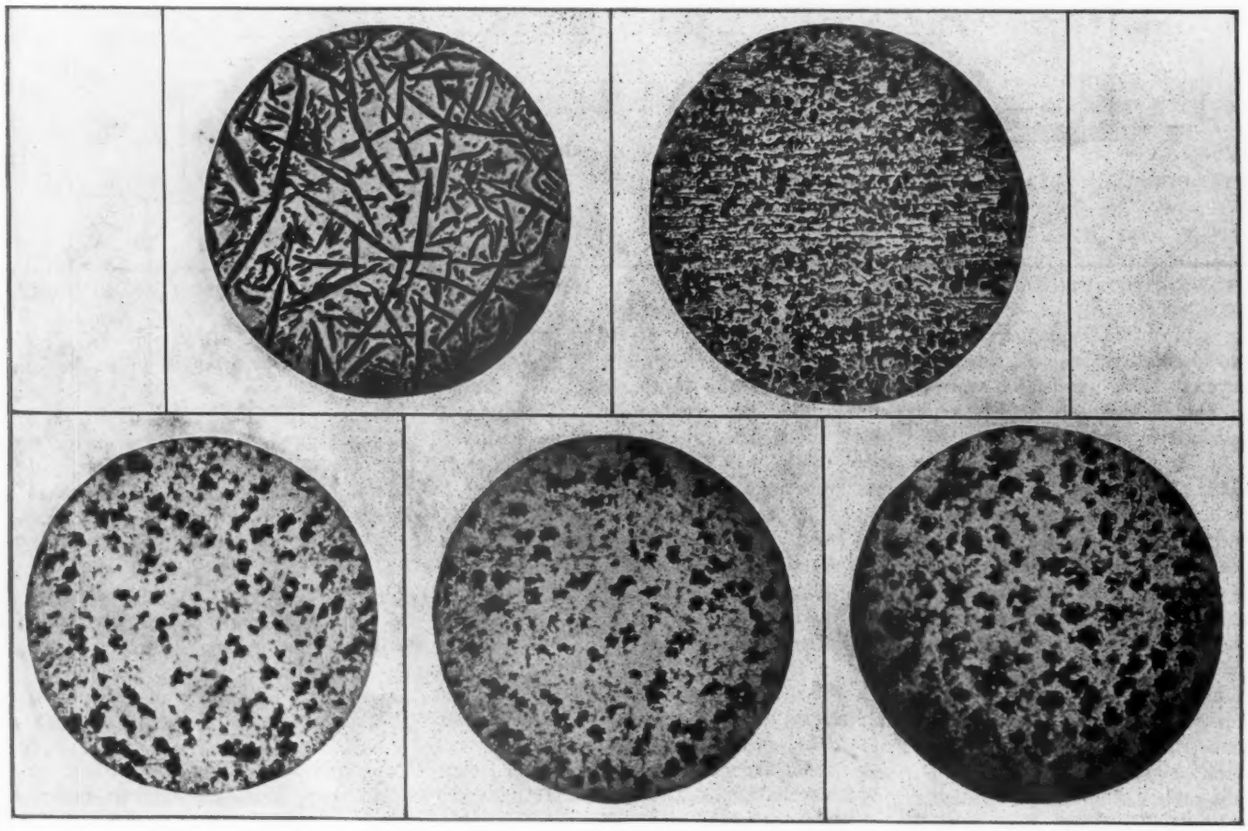


FIG. 1—PHOTOMICROGRAPH OF POLISHED, UNETCHED SECTION OF GRAY PIG IRON

FIG. 2—PHOTOMICROGRAPH OF POLISHED SECTION OF WHITE IRON

FIG. 3 — PHOTOMICROGRAPH ANNEALED MALLEABLE, ⅛ INCH FROM SURFACE

FIG. 4 — PHOTOMICROGRAPH ANNEALED MALLEABLE BETWEEN SURFACE AND CENTER

FIG. 5 — PHOTOMICROGRAPH ANNEALED MALLEABLE AT CENTER OF BAR

chemically with the iron, while if it be removed gradually from a pig iron in which the carbon would normally have existed as graphite, a point will finally be reached at which its influence in forcing the carbon to separate out as graphite will cease.

Removal of Silicon

It is an easy matter then to start with pig iron that is gray in fracture and in which all or most of the carbon exists as plates of free graphite, and end with an iron that is white in fracture and in which all of the carbon is combined chemically with the iron; it is a question solely of getting rid, in the air furnace, of such an amount of silicon as will accomplish this end. It thus becomes obvious that the manufacturer of malleable iron castings, by means of his air furnace, experiences no difficulty whatever in converting gray pig iron into white cast iron; which operation constitutes essentially the first step of the process. Many years ago it was discovered that if hard, brittle white iron were surrounded tightly by an oxidizing packing, such as iron oxide in any form, and then raised to and maintained at a temperature of about 1,500 degrees Fahr. for a few days, it would not only be changed into very soft and ductile iron, but some of its carbon would be removed during the interval. This constitutes the second step in the malleable iron process. Consequently, the first step toward getting soft and ductile castings in the malleable iron process, is to first get hard and ductile brittle castings, in which all of the carbon is combined chemically with the iron as carbide of iron, the hardest constituent in either iron or steel. The second step is to break up this hard constituent into carbonless iron and free carbon, both of which are soft. By the aid of photo-micrographs, what takes place during the second step of the process, that is, in the annealing ovens where the white and brittle castings are placed to be converted by time and temperature into finished castings, will be explained in a non-technical manner.

Fig. 1 illustrates a polished, unetched section of a piece of gray pig iron, the object of which is to show the plates or flakes of graphite that separate from the metallic iron, when the silicon is sufficiently high in the iron to force the carbon thus to separate. It will be noted that there is practically no regularity of either size or distribution of these flakes; therefore it is not to be wondered at that cast iron test bars show great irregularity in strength, even when poured from the same ladle of iron.

Fig. 2 shows a polished section of white iron, white because its silicon content was too low to force any of its carbon to separate out as graphite. The whole of the carbon consequently remains chemically combined with the metallic iron, invariably in the proportion of 6.67 per cent carbon to 93.33 per cent iron. The extremely hard carbide of iron is shown mostly in the white areas, but about 12 per cent of the dark areas consists of this hard constituent also, the reason for which it is not necessary to consider for the purpose of this article

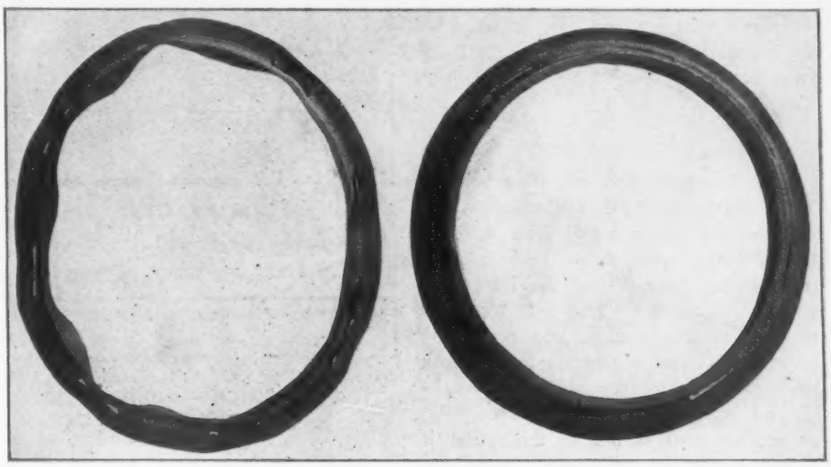


FIG. 7—ANOTHER VIEW OF MALLEABLE CLUTCH RING, MACHINED AND TESTED AS FIG. 6

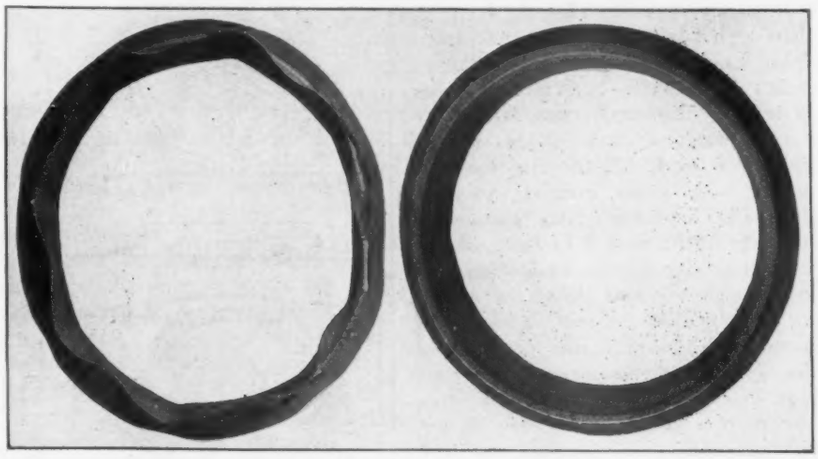


FIG. 6—MALLEABLE, AUTOMOBILE CLUTCH RING, MACHINED FROM 7-16 TO ⅛ INCH, SUBJECT TO HEAVY BLOWS TO TEST DUCTILITY AND STRENGTH OF CORE

As previously stated, carbide of iron is the hardest constituent that can exist in either pig iron or steel, but fortunately, as already indicated, it has been discovered that if it be heated to about 1,500 degrees Fahr., for many hours, it can be split into little nodules of free carbon and a mass of practically pure iron, the former being very soft and having no strength, and the latter being both soft and ductile and possessing high strength. An inspection of the polished sections of annealed malleable iron, Figs. 3, 4 and 5, will show that these little nodules of free carbon (the little black areas in the photomicrographs) are uniformly distributed throughout the entire section and are uniform in size, differing in both particulars from the manner in which the graphite occurs in gray iron.

To contend that white iron castings over ⅜ inch in section cannot be annealed as efficiently as castings of less thickness is to contend that a piece of white iron over ⅜ inch in section cannot be heated uniformly throughout its entire section to a temperature of 1,500 degrees Fahr. or over. This is manifestly absurd, for it must be admitted that in many different processes ponderous pieces of steel are being heated daily throughout their mass to any required temperature. The sole precaution in any case is to see that plenty of time

be given the operation. As it happens that in the annealing process in the manufacture of malleable iron castings, some seven days are consumed from the time the castings enter the ovens until they are withdrawn, if the breaking up of the hard carbide is not complete in the case of thick sections, this is certainly not due to lack of time to allow the piece to heat uniformly throughout. Moreover, there is no trouble whatever in maintaining the temperature of the ovens at any point under 1,900 degrees Fahr.

Thickness of Section

The direct question can now be put: What is the limit of thickness of section beyond which white iron will not be efficiently and completely annealed, that is, not have all of the hard constituent completely replaced by little nodules of free carbon and practically pure iron? The answer is plain. Any thickness of white iron can be thoroughly and uniformly annealed throughout its section, that is not so thick that it cannot be heated uniformly throughout, and in which the whole of its carbon content exists as carbide of iron. It has been shown that whether the carbon exists as *carbide* or as *graphite*, it is simply a matter of how *low* or how *high* the silicon may be in the casting. It has also been shown that the adjustment of the silicon is under the complete control of the manufacturer. If the silicon is as low as 0.30 per cent, it is possible to obtain easily, sections as thick as 6 inches, in which all of the carbon will exist as carbide of iron, although in this extreme case, to break up all of the carbide and completely replace it with free carbon and iron, a higher temperature than that normally used during the anneal is required. In sections 3 inches thick, all the carbon will exist as carbide of iron when the silicon is around 0.50 per cent, in which event neither a higher temperature nor a longer anneal than is customary in ordinary practice will be required. I have therefore placed this as the limit of thickness for efficient and complete annealing. The trade, however, does not call for malleable iron in which the sections are this heavy. The statement can be made that if the process is fully understood by the manufacturer, and he will adjust the silicon content in accordance with the heaviness of the work, no trouble from this source should exist, and none ever will.

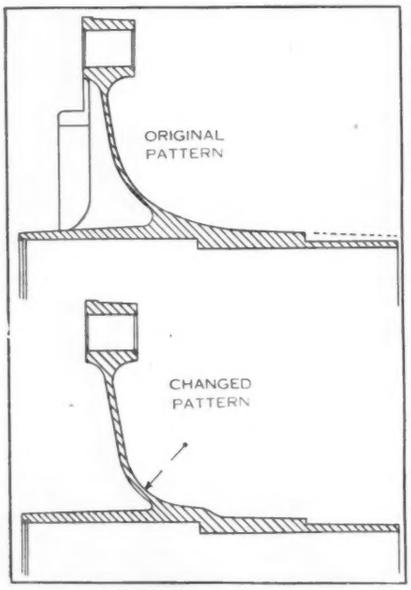


FIG. 8—ORIGINAL AND CHANGED PATTERN FOR MALLEABLE CASTING

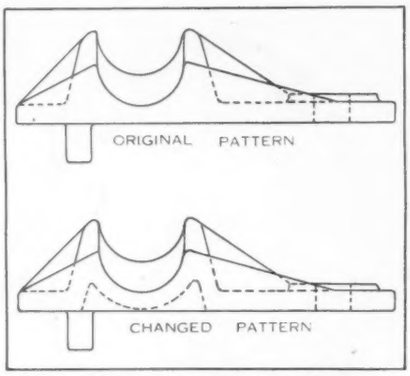


FIG. 9—ORIGINAL AND CHANGED PATTERN WHICH REDUCED THE AMOUNT OF METAL IN THE CASTING

Referring again to Figs, 3, 4 and 5, these photomicrographs were taken from an annealed malleable section 2 inches in diameter and several inches in length. The sample was cast at my request from a heat in the regular course of work. While the company makes fairly heavy castings, none of the parts approaches this sample in thickness. Still, as will be seen, the silicon in this company's white iron was low enough to cause all of the carbon to form carbide of iron in a 2-inch round. This sample was annealed in the oven with the company's other castings, in exact accordance with the regular practice of the shop. Fig. 3 was photographed at a spot about ⅛ inch from the surface; Fig. 4, at a spot midway between the surface and the center; and Fig. 5 directly at the center. A close inspection and comparison of these three photographs should satisfy the most skeptical that this piece was annealed throughout, and that all of the hard carbide was broken up into free carbon and soft iron. Accompanying this sample was another, 4 inches in diameter, the central part of which I found contained considerable graphite in the form of flakes, which from their shape could be identified as having resulted from the separation of some of the carbon during the solidification of the white iron, showing that in this case the silicon in the normal mixture was not sufficiently low to have forced all of the carbon to combine with the iron, although had the silicon been somewhat lower, no difficulty in this particular would have been experienced.

Removing Skin

In connection with the oft-repeated statement that if the skin of a malleable casting be removed, and the core tested, the latter will be found to be more or less worthless and that malleable castings are strong and ductile by virtue principally of the metal in the skin, I wish to state that there is no question whatever that the metal in the skin of well-made malleable iron is slightly superior to that which constitutes the main bulk of the casting, but only in the case of poor malleable iron can a really great difference in strength between skin and core be noted; the poorer the malleable the more pronounced this difference. Malleable castings are not unique in this particular, for the metal in the skin of most steel castings is stronger than the central part of the casting, although not for the same reason that obtains in the case of malleable iron. The skin of malleable castings is practically decarbonized iron, the structure being uninterrupted by the presence of any little

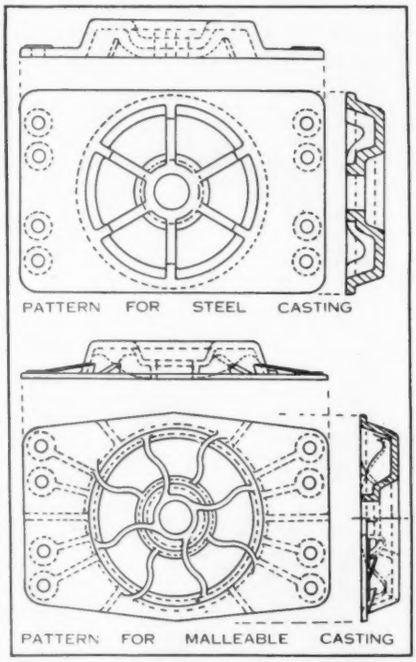


FIG. 10—PATTERN FOR MALLEABLE CASTING AND HOW IT WAS CHANGED WHEN MADE IN STEEL

nodules of free carbon. The structure of the core, however, differs from that of the skin, only in that throughout it little nodules of free carbon are interspersed. That in good malleable iron these little particles of free carbon do not act in a way to injure the structure to any appreciable extent, I have satisfied myself by numerous tests from time to time. To illustrate this fact, I have secured two castings of an automobile clutch ring, shown in Figs. 6 and 7. The 7/16-inch thick rim of the casting was machined down to a thickness of ⅛ inch, after which it was subjected to repeated heavy blows with a hammer to test the ductility and strength of the core left after machining. It will be seen that the metal of the core, in this instance, was of great strength and ductility, was able to withstand great punishment without developing cracks of any magnitude. It is most likely true that the metal in the skin of this casting was slightly superior to that in the core, but I feel confident that the difference was not great, and I repeat that in good malleable castings, while the metal in the skin is a little superior to that of the core, the difference is but slight. The photographs referred to speak for themselves. Some manufacturers of malleable iron have not kept pace with the advances made in malleable practice; some do not even understand the rationale of the process, or lack good manufacturing equipment, and while, fortunately, these do not predominate, there are enough of them in existence to throw much undeserved discredit on one of our large, important and growing industries. I am convinced, however, that the constructing engineer has, owing to improperly designed patterns, contributed unintentionally in numerous instances, to this situation. The worst offenders in this particular, however, are the engineers for the railway car builders.

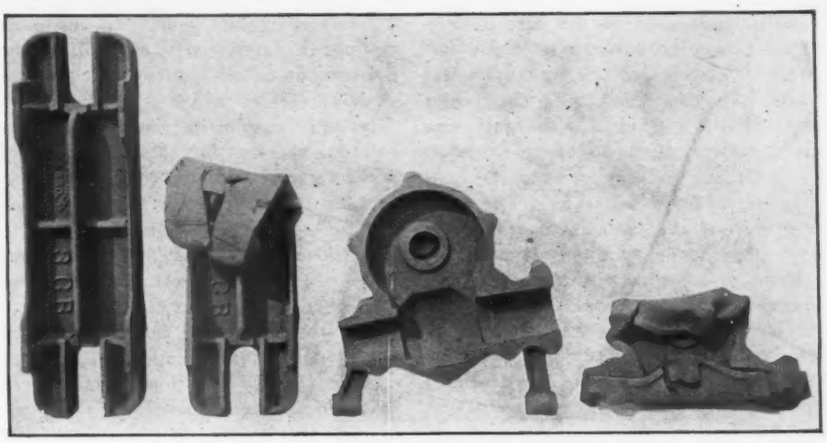


FIG. 12—MALLEABLE CASTINGS BEFORE AND AFTER HAMMERING

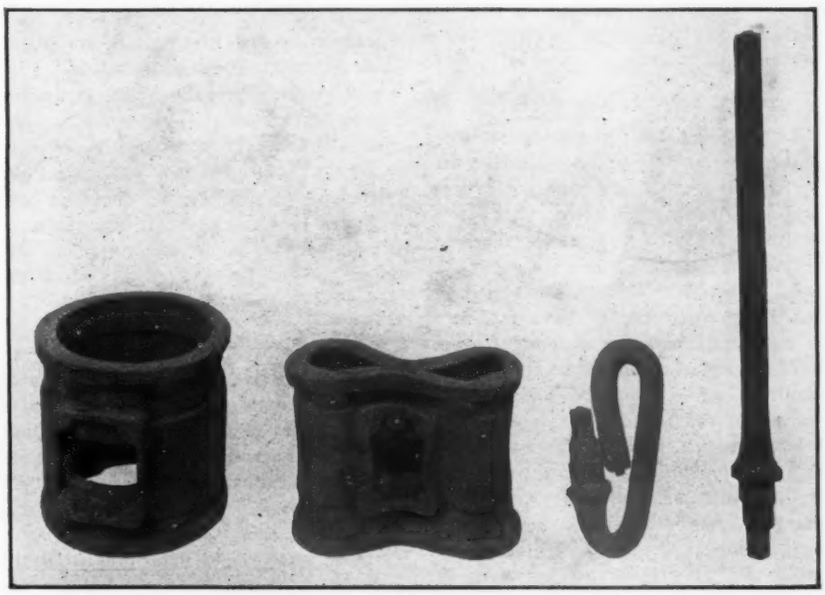


FIG. 11—MALLEABLE CASTINGS BEFORE AND AFTER BEING SUBJECTED TO HAMMERING AND BENDING TESTS

If the question of shrinkage and contraction be not properly considered, if the apportioning of thick to thin sections be not adjusted in accordance with correct principles, no matter how superior may be the metal *per se*, failure is the certain outcome. The remedy should be obvious. Practically all of the makers of malleable castings have on their staff men who are proficient in the design of patterns from which to cast malleable. Much delay, much irritation, and a great deal of injustice will be eliminated, and a much stronger casting for the same weight of metal will often be produced, when closer relationship and co-operation exist between the engineer who designs the malleable part of any particular machine and the malleable patternmaker at the foundry. Lack of time has prevented my securing more glowing examples than the ones here shown, of how small need be the alteration in a pattern, in many instances, to produce good results where bad ones previously obtained. The changes shown in Fig. 8, although slight indeed, made the difference between success and failure. The same

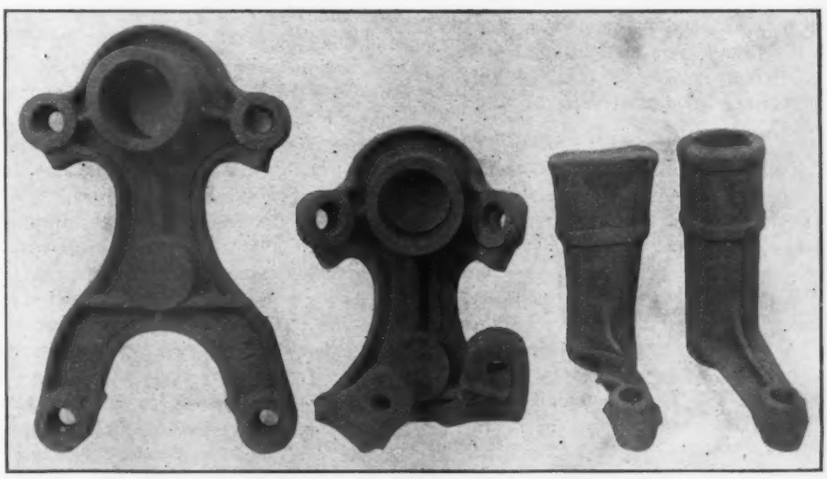


FIG. 13—MALLEABLE CASTINGS BEFORE AND AFTER HAMMERING, BENDING AND TWISTING TESTS

remark holds good in the case of Fig. 9, the change producing not only a satisfactory casting but one containing less metal. In connection with the center plate shown in Fig. 10, the following are the facts: Complaint was made by the railroad that these malleable castings were failing in service. The manufacturer of the castings made the request that he be permitted to alter the patterns in accordance with what his experience indicated would remedy the trouble. This privilege was not granted. The road then decided that malleable iron castings could not be depended upon in this particular case; so it was decided to have the castings made of steel. The steel men also objected to the design of the pattern, and, as almost always happens when a change is made from malleable iron to steel, they were allowed not only the privilege denied the others, but, as can be seen by reference to the drawing, they were permitted to thicken the sections by ¼ inch almost throughout. That changes were made in both design and weight is soon forgotten, but not that the steel casting stood up to the work and the malleable casting failed.

Physical Properties

In Figs. 11, 12 and 13 are shown malleable castings which have been hammered, bent and twisted. They eloquently illustrate the fact that when malleable castings are made by those who understand the process, castings that possess many valuable characteristics are produced. When toughness and ductility, ease of machining and low cost are considered, I do not know what metal can compete successfully with good malleable iron.

The tensile strength of good malleable iron will vary between about 38,000 to 56,000 pounds per square inch. When extreme ductility is desired, it is manifestly incompatible to specify high tensile strength. As in the case with carbon steel, so with malleable iron, ductility goes hand in hand with low ultimate strength; if high ultimate strength is desired, it can be obtained only by a sacrifice of ductility.

Elastic Limit of Malleable Iron

The elastic limit of good or of even indifferent malleable iron is equal to that of wrought iron and frequently exceeds it. When comparisons are made between this material and other metals, it would be more fair to consider the elastic limit rather than the ultimate strength, for it is the former upon which the engineer actually bases his calculations. The elongation and reduction of area of malleable are, of course, considerably less than that of either wrought iron or soft steel. That both of these properties are high enough to impart great value to malleable castings is impressively attested by the illustrations of the abused castings previously referred to.

It is the custom in plants of fair size to run various furnaces on mixtures for different classes of work. The mixture from one furnace is not as well adapted to one class of casting as to some other. If the user of the castings will only take the manufacturer into his confidence and explain the use to which any particular casting is to be put, and the work expected of it in service, I know that loss of time will be avoided, and a more superior product manufactured. Some consumers are under the false impression that for competitive reasons they should lighten their castings. This generally necessitates the introduction of more cores in the mold, the result being that the manufacturer is obliged to charge more per pound.

Specifications

I presume that specification is of more interest to the membership than perhaps any other one question in connection with this material. I have no desire to usurp the duties of the committee having this matter in hand, the work of which in all that has been done has been so commendable, but a few words in connection with the Society of Automobile Engineers malleable iron specifications will I trust be taken in the spirit in which they are intended. I believe that a mistake has been made in specifying an upper limit for silicon. As a matter of fact, it is well known that the higher the silicon in the white iron casting, provided the totality of the carbon in the casting exists in the state of carbide of iron, and all other conditions are correct, the better will be the finished product. I have shown that the manufacturer is obliged to eliminate his silicon to a point where all of the carbon will remain as carbide, and also that the extent to which he must carry out this elimination depends wholly upon the heaviness of the section. It is exceedingly rare that he errs in getting the silicon too high, because he does not need a chemical analysis to safeguard this, as all that he has to do is to keep breaking his test sprue until he sees by the fracture that the iron is white, and that there are no particles of graphite carbon in the fracture. He is more concerned in this particular than the purchaser can ever be, and to this extent the purchaser is protected. To specify an upper limit for silicon is about as necessary as to specify that the manufacturer shall pour his iron in the molds at a temperature sufficiently high to successfully run his castings. You can rest assured that he is going to look after the upper limit of silicon with as much fidelity as he will be sure that the iron is hot enough to avoid trouble through misruns.

On the other hand, it would be wise to specify a limit beyond which the silicon shall not drop, because not only does the manufacturer err frequently in this direction in the making of black heart iron, but he is handicapped by having no reliable means of telling just when he is on the danger line. Analysis would take too long and the fracture gives no true indication. If the silicon is too low, an inferior product will result, and still the purchaser, if he be held to his specification, can be forced to accept the castings.

The Society of Automobile Engineers specification allows the manganese to be as high as 0.70 per cent. No one ever saw and no one ever will see black heart malleable iron of good quality with such a manganese content. Provided certain precautions are taken, and certain ratios made between certain elements in the product, it is possible to make a good product in which the manganese might be as high as 0.40 per cent, but to do so the manufacturer would have to be a master of his business and to know how to offset the evil effect of manganese.

Per Cent of Manganese

The upper limit for phosphorus given, 0.20 per cent, is all right, but it is actually the extreme upper limit that should be tolerated. The American Society for Testing Materials allows 0.225 per cent as an upper limit for phosphorus, but this is by far too high. I feel confident that a good product could not be obtained if this limit were reached.

No mention is made in the Society of Automobile Engineers' specification as to carbon content, or the permissible amount of combined carbon tolerated; nor is any limit placed upon the allowable amount of total carbon.

Stove Founders Meeting

At the recent annual meeting of the Stove Founders' National Defense Association, held in New York City, the following additional firms were admitted to membership: Magee Furnace Co., Boston; Crescent Stove Works, Evansville, Ind.; Boynton Furnace Co., New York City; Home Stove Works, Chicago, and Roberts, Winner & Co., Quakertown, Pa.

George Mitchell was re-elected president and Thomas J. Hogan secretary. Other officers were elected as follows: William H. Cribben, first vice president, and Arthur W. Walker, second vice president.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form

SPECIFICATIONS FOR EXHAUST SYSTEMS.

(*Continued from Data Sheet No.* 140)

Dust Separators

The following table contains dimensions of separators suitable for metallic dusts and wood shavings:

Diameter of fan outlet, inches.	Area of fan outlet, square inches.	Openings in Separator. Size of inlet, inches.	Openings in Separator. Area of inlet, square inches.	Openings in Separator. Diameter of air outlet, inches.	Openings in Separator. Area of air outlet, square inches.	Openings in Separator. Diameter of dust outlet, inches.	Dimensions of Separator. Outside diameter of cylinder, inches.	Dimensions of Separator. Height of cylinder, inches.	Dimensions of Separator. Length of cone, inches.
5	20	2½ x 9	23	8½	56	3	29½	14	26½
6	28	3 x 10½	32	10	78	4	35½	15½	32½
7	38								
or	or	3½ x 13	47	13	132	6	41½	18½	37½
8	50								
9	63	4½ x 16	72	15	176	6	47½	21	43½
10	78	5 x 18	90	17	227	6	53½	23	50
11	95								
or	or	5½ x 21	115	20	314	10	59½	26	56
12	113								
13	133								
or	or	6½ x 24	156	23½	433	10	65½	29	61½
14	154								
15	177	7 x 27	189	26	531	10	71½	32	67½
16	201								
or	or	8 x 30	240	28	615	10	77½	35	72½
17	227								
18	254	8½ x 32	272	31	754	10	83½	38	77½
19	283								
or	or	9 x 35	315	33	855	10	89½	41	82½
20	314								
21	346	9 x 40	360	36	1,017	10	93½	46	85½
22	380	10 x 41	410	39	1,194	10	97½	47	89
23	415								
or	or	10½ x 43	451	41	1,320	11	101½	49	93
24	452								
25	491	11 x 45	495	44	1,520	11	105½	51	97
26	531	11 x 48	528	46	1,662	12	109½	54	99½
27	572	11 x 51	561	49	1,885	12	113½	57	103½
28	621	11½ x 54	621	52	2,123	12	117½	60	109½
29	660	12 x 57	684	55	2,375	12	121½	63	111½
30	707	12 x 60	720	58	2,642	12	125½	66	115½
31	754								
or	or	12½ x 63	807	61	2,922	13	129½	69	118½
32	804								
33	855	13 x 66	858	64	3,217	13	133½	72	122½
34	908	13½ x 69	932	67	3,525	13	137½	75	126½
35	962	14 x 72	1,008	70	3,848	14	141½	78	129½
36	1,017								
or	or	14½ x 75	1,087	73	4,185	14	145½	81	133½
37	1,075								
38	1,134	15 x 78	1,170	76	4,536	14	149½	84	137½
39	1,194								
or	or	15½ x 81	1,255	79	4,901	14	153½	87	141½
40	1,256								
41	1,320	16 x 84	1,344	82	5,281	14	157½	90	145½

(*Continued on Data Sheet No.* 142)

SPECIFICATIONS FOR EXHAUST SYSTEMS.

(*Continued from Data Sheet No.* 141)

Dimensions of Branch Pipes

The following table gives the diameter in inches of the main suction duct at any point for any number of uniform size branch pipes when the area of the main at any point is made equal to the combined areas of the branch pipes preceding that point plus 20 per cent, the minimum required by the specifications:

Number of branch pipes.	Diameter of Branch Pipes in Inches. 3	3½	4	4½	5	5½	6	6½	7
	Area of Each Branch Pipe in Square Inches. 7.07	9.62	12.566	15.9	19.635	23.758	28.274	33.183	38.485
	Area of Each Branch Pipe Plus 20 Per cent (Square Inches). 8.484	11.544	15.08	19.08	23.562	28.51	33.93	39.82	46.182
1	3⅜	3⅞	4⅜	5	5½	6	6⅝	7⅛	7¾
2	4¾	5½	6¼	7	7¾	8⅝	9¼	10⅛	10⅞
3	5¾	6⅝	7⅝	8⅝	9½	10½	11½	12⅜	13¼
4	6⅝	7¾	8¾	9⅞	11	12⅛	13⅛	14¼	15⅜
5	7⅜	8⅝	9⅞	11	12¼	13½	14¾	16	17⅛
6	8⅛	9½	10¾	12⅛	13½	14¾	16⅛	17½	18¾
7	8¾	10¼	11⅝	13⅛	14½	16	17½	18⅞	20¼
8	9⅜	10⅞	12⅜	14	15½	17⅛	18⅝	20⅛	21¾
9	9⅞	11½	13⅛	14⅞	16½	18⅛	19¾	21⅜	23
10	10½	12⅛	13⅞	15⅝	17⅜	19⅛	20¾	22½	24¼
11	11	12¾	14⅝	16⅜	18¼	20	21⅞	23⅝	25½
12	11½	13⅜	15¼	17⅛	19	20⅞	22¾	24¾	26⅝
13	11⅞	13⅞	15⅞	17⅞	19¾	21¾	23¾	25¾	27¾
14	12⅜	14⅜	16½	18½	20½	22⅝	24⅝	26¾	28¾
15	12¾	14⅞	17	19⅛	21¼	23⅜	25½	27⅝	29¾
16	13¼	15⅜	17⅝	19¾	22	24⅛	26⅜	28½	30¾
17	13⅝	15⅞	18⅛	20⅜	22⅝	24⅞	27⅛	29⅜	31⅝
18	14	16⅜	18⅝	21	23¼	25⅜	27⅞	30¼	32⅝
19	14⅜	16¾	19⅛	21½	23⅞	26¼	28¾	31⅛	33½
20	14¾	17⅛	19⅝	22⅛	24½	27	29½	31⅞	34⅜
21	15⅛	17⅝	20⅛	22⅝	25⅛	27⅝	30⅛	32¾	35⅛
22	15½	18	20⅝	23⅛	25¾	28⅜	30⅞	33½	36
23	15¾	18½	21⅛	23¾	26¼	29	31½	34¼	36¾
24	16⅛	18⅞	21½	24¼	26⅞	29⅝	32¼	34⅞	37⅝
25	16½	19¼	22	24¾	27½	30⅛	32⅞	35⅝	38⅜
26	16¾	19⅝	22⅜	25⅛	28	30¾	33½	36⅜	39⅛
27	17⅛	20	22⅞	25⅝	28½	31⅜	34⅛	37	39⅞
28	17½	20⅜	23¼	26⅛	29	32	34¾	37¾	40⅝
29	17¾	20¾	23⅝	26⅝	29½	32½	35½	38⅜	41⅜
30	18	21	24	27	30	33	36	39	42

(*To be Continued*)

A Well-Equipped Shop for Core Manufacture

Description of the New Core Department Installed by the Northwestern Malleable Iron Co., With Details of Sand-Handling Methods

CORE room design is a subject which receives but little attention from many foundrymen. Generally, a corner in the molding room with a few benches and space for sand heaps is considered satisfactory. A census would reveal a surprising number of shops in which the wheelbarrow and shovel are used exclusively for handling and mixing sand. Core rooms which have been thoughtfully laid out are, therefore, always of interest and are full of suggestion for the wide-awake manager. A department of this character, with space for 60 coremakers, has recently been completed by the Northwestern Malleable Iron Co., Milwaukee.

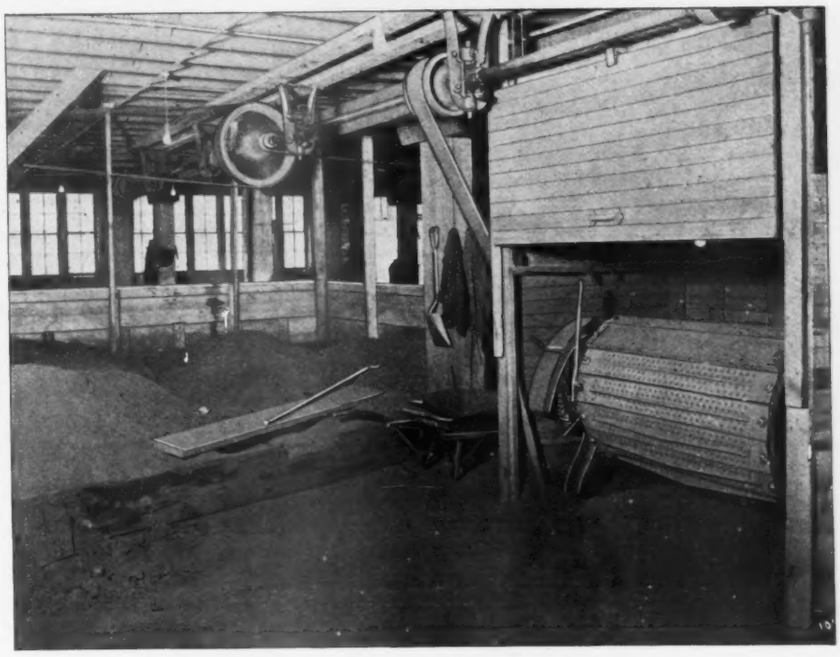


FIG. 2—RECLAIMING OLD MOLDING SAND FOR CORES

General Arrangement

It has been designed for producing small malleable foundry cores in large quantities. The work is done entirely at benches by boys using metal or brass-bound wooden core boxes. The core room, which is 60 x 75 feet, is on the second floor and a room beneath of the same size is utilized for handling and mixing the sand. This arrangement separates the two most important functions in coremaking so that special attention may be given to preparing and mixing the sand without interfering with the operations of those engaged in actually making cores.

Considerable old molding sand is used in the core mixture, including sweepings from the gangways. This material is collected in dump carts and is hauled to a corner in the sand mixing room, Fig. 2, set aside for handling it. Here it is passed through a rattler in which the sand is separated from the nails, spilled iron and other miscellaneous rubbish which it contains. The rattler is of the usual barrel stave type, 48 inches long and 36 inches in diameter. Holes ½-inch in diameter have been punched through the staves to allow the sand to sift out when the machine is in operation. The rattler is surrounded by a wooden enclosure which prevents the dust from escaping into the room and is belted to a motor-driven line shaft. The old molding sand which has passed through the rattler is piled in a bin as shown at the left in Fig. 2. Before being mixed with the new sand and binder, it is run through a power riddle having a ¼-inch mesh. Several mixtures are used although the following has been found most satisfactory; 60 parts riddled old molding sand; 20 parts new molding sand; 20 parts silica sand and 1 part Glutrin.

FIG. 1—OIL SAND MIXING DEPARTMENT SHOWING RIDDLE OPERATED BY ECCENTRICS

For mixing oil sand for small cores, the equipment shown in Fig. 1 has been installed in another corner of the sand room. It includes a power-driven riddle similar to that used for screening the old molding sand, together with a mixer furnished

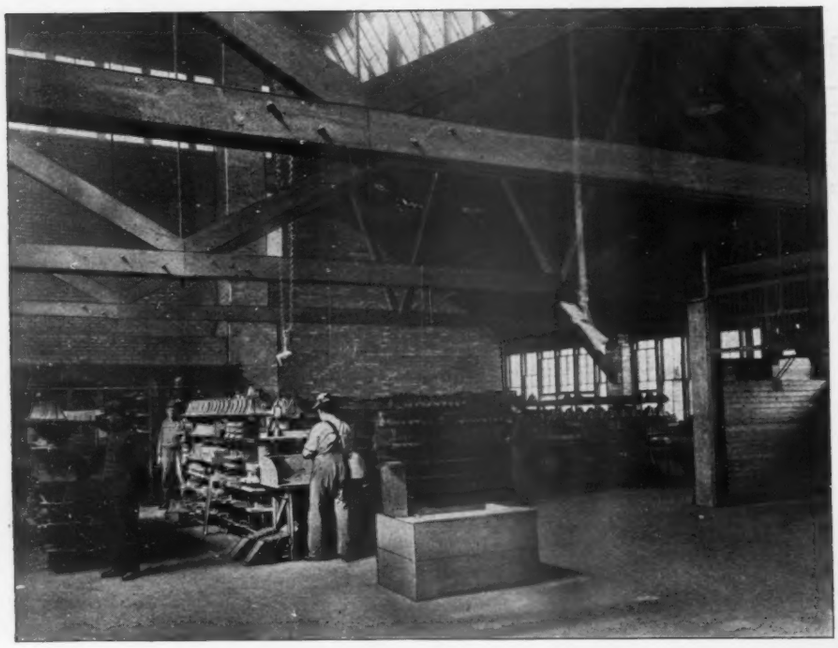


FIG. 3—GENERAL VIEW OF THE CORE ROOM

by the Standard Sand & Machine Co., Cleveland. The riddle has some interesting features. It consists of a wooden box 4 feet long, 3 feet, 6 inches wide and 1 foot deep, sliding on a cast iron frame and oscillated by two eccentrics on a jack shaft. The latter is belted to a countershaft overhead with tight and loose pulleys. The eccentrics have a throw of about 6 inches and operate at a speed of approximately 150 revolutions per minute.

The mixed sand is dumped into the boot of a vertical conveyor or bucket elevator which deposits it in bins on the core room floor. The elevator, which was furnished by the Chain Belt Co., Milwaukee, is shown in Fig. 5. It is 34 feet in length between centers and consists of a series of malleable iron buckets mounted on a single strand of chain belt. It travels at the rate of 200 feet per minute and at this speed has a capacity of 25 tons of core sand per hour. It is driven by a 110-volt, direct current motor which is connected to the elevator by a belt and a train of gears. The elevator is equipped with a flexible spout so that the sand may be discharged into any one of several bins.

A general view of the core room is shown in Fig. 3. The benches are arranged around the walls with the racks in the center of the room. The latter were designed and built by the company and their construction is shown in Fig. 4. Each rack consists of a series of ⅜ x 2-inch rectangular upright bars or posts to which 1¼-inch steel tees are bolted, forming stringers on which the core plates can be placed. The racks are made in pairs and are held together with steel spacers as shown in Fig. 4; T-bars are used for the stringers instead of angles because they have greater strength for a given weight. The various members of each rack are bolted together instead of being riveted so that they may be readily taken apart for storage or removal.

The cores are dried in a battery of four Whiting shelf ovens arranged to burn coke, with the grate on the first floor below. Each oven section has 6 shelves. Two small, coke-fired ovens are also installed.

For connecting the core room with the ground floor, a 3,000-pound power-driven elevator, shown at the right of Fig. 3, has been installed. It was furnished by the A. Kieckhefer Elevator Co., Milwaukee. The core room is provided with a monitor for ventilating purposes and is lighted at night by 150-watt tungsten lamps carried in bowl-shaped reflectors suspended from the ceiling. To avoid loss of time by the workmen, a special toilet and wash room has been fitted up in one corner of the core room.

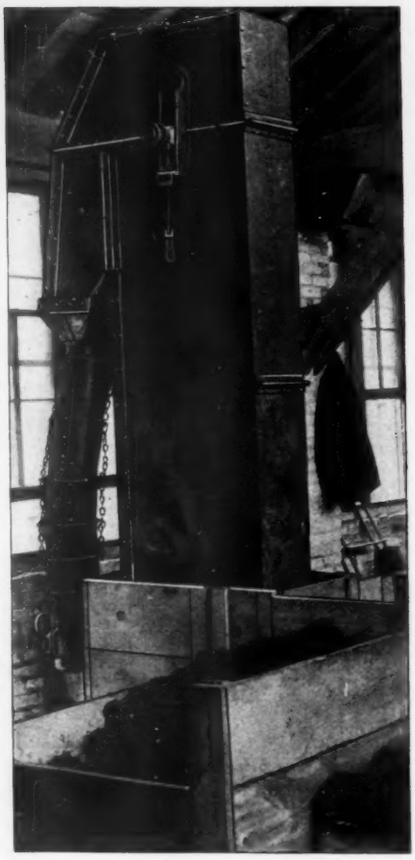


FIG. 5—DISCHARGE END OF CORE SAND ELEVATOR

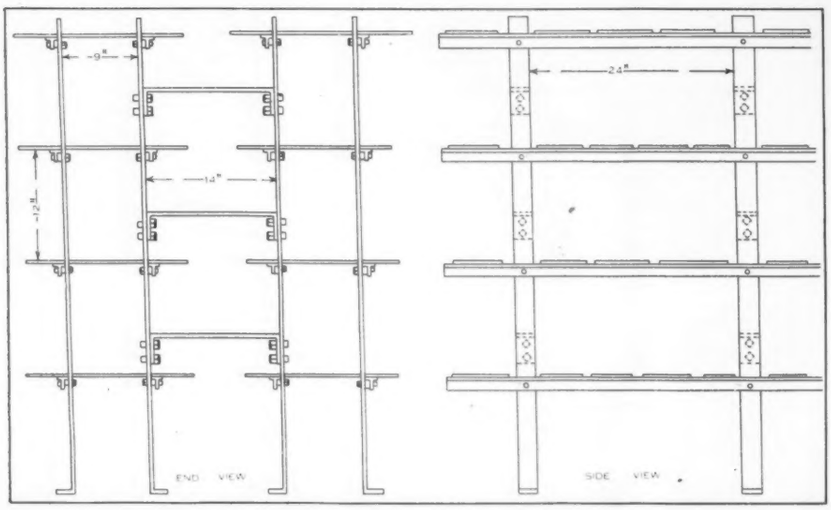


FIG. 4—BOLTED STEEL CORE RACK

Economical Foundry Cost-Keeping Methods*

How the Casting Manufacturer Can Accurately Ascertain His Cost of Production by the Adoption of a Simple System

By E W Riker

FOUNDRYMEN, as a group of industrial owners, are perhaps the most skeptical class of manufacturers regarding the installation of a cost system—and they hesitate the longest. This is not surprising when one considers the aversion which foundrymen generally have to the installation of any system of operation that involves detail or an interruption to the settled state of affairs, with a fear of added cost of execution of the system in way of clerical help. This, however, need not be the case if the system—whether it be a cost system or some other method of operation—is designed to fit the foundry in which it is installed and is, therefore, appropriate and practical.

One of the discouragements to foundrymen is the failure to obtain results from cost systems they have considered and perhaps tried, due chiefly to incompetent professional advice. This is one of the reasons for their skepticism. There are comparatively few foundry specialists in the field today who have had sufficient experience in foundry cost work and practice to qualify them as advisers and who are capable of devising and installing a foundry cost system and other foundry methods that do not involve extravagant expenditures to maintain. Notwithstanding this, the foundryman needs a cost system and needs it more today than ever before; it is positively necessary to foundry efficiency, economy and progress. The system need not be a complicated or top-heavy one, embodying a mass of detail with a large clerical force to operate, but it can be a simple, plain and clear statement of current cost conditions; accurate and practical and so valuable that a foundryman or manufacturer who once gets such a system never regrets it nor begrudges the money he spent for its installation.

Science of Management

We hear a great deal, nowadays, of scientific management and how efficiency can best be secured by purely scientific methods; but these methods are apt to be ultra-refined and are rather expensive affairs to execute, especially when applied to foundry practice, and are not always advisable by any means. Let us consider the science of management as distinguished from scientific management, which appeals strongly to a number of practical foundrymen and manufacturers and is a discrimination that permits a sane, sensible and orderly arrangement of affairs for the economical transaction of business, whether applied to a foundry, a factory or other commercial enterprise. Science is *systematized knowledge* and in these days of business activity, with competition growing keener day by day, it is necessary for executives to have all the *knowledge* practically and economically obtainable relating to current operations of their businesses; the best way to secure this knowledge is through the operation of a dependable cost system that gives the executive control of his business. The cost system is called the main spring of the business, but it must be right and it must be practical; and when installed, it ought to be clearly understood that the system is not automatic and that its value depends largely upon the understanding the chief executive of the business has of its principles and its possibilities.

No business is made a success by the cost system alone, though business success is rarely secured to its full extent without the aid of a cost system. It is the chief instrument used to attain a high degree of efficiency through intelligent, energetic and enthusiastic management, made practical by good organization, permanent policies and business integrity.

Accurate Cost Control

Accurate cost control of a foundry by economical methods is possible beyond the question of a doubt. A foundry cost system can be devised to fit the foundry for which it is designed, that will absorb and account for every disbursement for material and labor, whether this is a direct or productive item or an indirect or non-productive charge. Furthermore, these disbursements may be separated or classified to divisions or departments of the foundry to show current costs of departments for efficiency in foundry management, and also separated and charged to classes of castings or to individual orders to show complete cost of product by classes or by specific orders. All of this can be tabulated and presented *weekly* instead of *monthly*, as is done in some foundries.

The usual divisions of an iron foundry recognized as productive departments are:

A.—Cupola;
B.—Core room;
C.—Molding;
D.—Cleaning and chipping.

The non-productive or indirect expenses, known as foundry expenses, overhead charges, or burden, include:

Superintendent and foremen;
Foundry clerks;
Shipping;
Yard men;
General laborers;
Crane men;
Machinists, carpenters and blacksmiths;
Freight and cartage;
Pattern repairs and renewals;
Tool repairs and renewals;
Bad castings;
Defective castings.

These expenses are taken care of through the medium of standing order numbers to which they are charged and tabulated for distribution to the productive departments and classes of castings as part of the costs, and further to inform the superintendent or foreman in charge, currently of variations in this class of disbursements for prompt action when any specific item or items show unusual increases.

Fixed Charges

The power, heat, light, water and protection expenses are treated in a manner similar to the other foundry expense disbursements and are distributed proportionately to the productive departments and classes.

The fixed charges, such as fire insurance, indemnity insurance, depreciation and interest, are absorbed into cost of product, but are shown on the weekly report separately, for the reason that these items, being *fixed* cannot be increased or decreased by act of the foundry superintendent or foreman and, therefore, should not be included with other items of foundry expenses which can be increased or decreased by the superintendent or foreman, according to the degree of efficiency he shows in the management of the foundry affairs.

Foundry betterments, or permanent investments, such as real estate, buildings, machine tools, general tools, patterns, power transmission, piping, electrical equipment, etc., are handled by the usual accounting methods applied to this class

*Presented at the June meeting of the Philadelphia Foundrymen's Association.

of property accounts, but the charges thereto are not absorbed in current cost of product, only their upkeep and depreciation.

Starting with the raw material, a cupola report is prepared showing grades of pig iron melted, with quantity and value of each, and also quantity and value of machinery and foundry scrap to show total melt; from this is deducted the returns and bad castings, which gives the net cost of metal melted. To this is added the cost of fuel and supplies, such as coke, fire sand, fire clay, brick, limestone, etc., together with the labor engaged upon the cupola work and the power consumed to give net cost of melt, which is reduced to a rate per pound of metal melted. From this melt and upon the cupola report the pounds of castings produced are shown. The cupola report also shows:

(1)—Per cent of good castings to gross melt.
(2)—Per cent of bad to total castings.
(3)—Per cent of returns to gross melt.
(4)—The melting loss.
(5)—The ratio of this loss to melt.

The report is complete and includes every item of cost of cupola operation reduced to a net cost per pound of metal melted from the cupola spout to the ladle, ready to pour for subsequent use in ascertaining cost of castings per pound by classes and in total, or cost of castings by jobs or pieces. The report also is decidedly helpful to the foundry superintendent or foreman in measuring the efficiency of this important foundry department.

Similar reports are prepared for the core room, the molding, cleaning and chipping departments, to show cost of operation of these divisions, both for department efficiency and to include in final summary of cost of castings.

Overhead Expenses

The overhead expenses are tabulated in one report to show the disbursements in detail covering this class of cost. This report also shows cost of power, heat, light, etc., and the amounts that are apportioned weekly to cover the fixed charges. Thus all money expended for material, labor and foundry supplies, whether for direct or indirect use, is properly accounted for.

Finally, all these reports are summarized on a cost of casting sheet to show total cost of operation by departments and total cost of castings by classes with notations of period or average costs to date for departments and classes. These several reports form the weekly cost statement with every item of cost absorbed and capable of proof with the books of account.

Additional reports in the nature of statistics may be prepared from the weekly cost reports, arranged to show results comparatively by weeks as a further guide to the superintendent in his effort to promote efficiency. A statement of comparative results arranges facts developed in the cupola department relating to good castings, bad castings, returns, total from melt, melting loss, total melt, average melt per day, defective castings, cost of metal, ratio of foundry expense to productive labor, average castings per day both good and bad and per molder, and other useful data to indicate to the foundry superintendent how these regular features of the foundry are running along and what variations develop. An analysis of the product and of foundry expenses may also be arranged comparatively to inform the superintendent of variations in these items.

These statistical statements are not actually a part of the weekly cost report, but are found helpful to the foundry management in watching the trend of affairs.

Stock Control

In connection with the cost system and auxiliary to it, is a system of stock control which can be operated in a simple manner to properly regulate purchases of material and foundry supplies and to properly govern their use. A stores and stock system not only provides a current inventory, but effectively prevents careless and indifferent buying, overstocking and waste and furnishes a means of inspection of this class of property that is desirable and helpful in the effort to economize in foundry material and supplies.

One of the strongest and most effective features of the foundry cost system, outlined in this paper, is the weekly report scheme for the reason that reports compiled so frequently give the superintendent or foreman in charge of the foundry the opportunity to observe irregular developments in cost of operation. For this reason alone the weekly reports are much more valuable to the foundry management than are those which are prepared only once a month.

In preparing the weekly report, the foundry cost clerk is assisted by suitable forms of recording and reporting data from the several departments which he needs for his report. This data comes to him daily on analysis sheets, thus assembling the figures needed for his weekly report each day to further enable him to compile his report at the end of the week promptly and without serious effort.

There is no theory about the cost system referred to, for its practical application has been demonstrated in various large foundries and its effectiveness proven. Its execution does not involve an undue amount of clerical or other expense; on the contrary, the system can be operated so economically that a foundryman who wants to know his costs can hardly afford to neglect the installation of the system.

Two points in connection with the installation of new cost system, whether in a foundry or other industrial plant, must be considered and clearly understood, namely, it takes time and perseverance. Various elements must be reckoned with and various obstacles must be overcome, but above all, to make the cost system a complete success it must have the substantial support of the chief executive of the business against all obstacles and objections.

A great deal depends upon the cost system; its elements must be thoroughly understood and it must absorb all items of cost, both direct and indirect. It is hazardous to the business to use cost figures that do not represent the total expenditures for labor, material and expense and which cannot be proved. If figures are used that do not include or absorb these three chief elements of cost, selling prices are apt to be made that will not show a profit when the fiscal year's balance sheet is prepared.

It is not a difficult matter to ascertain accurately the amounts expended for direct labor and material; this is quite simple, but just how to ascertain the overhead and apportion it equitably and correctly to be sure that all overhead expense is absorbed, requires careful study and a knowledge of the subject obtained from years of actual practical experience. It is safe to assert that a large majority of industrial owners and managers do not fully comprehend what a complete cost system really means and that such a system is just as necessary to permanent and increasing business prosperity as is good organization, efficient management, adequate equipment and capable workmen.

Elements of a Cost System

As previously stated, the elements of a cost system must be thoroughly understood and correctly applied. These elements are:

1.—*Material:* That material which becomes part of the finished product.
2.—*Productive Labor:* That labor which can be determined by a specific amount or rate and can be directly charged into cost of product.
3.—*Factory Expense:* The large number of charges which are necessary to maintain productive labor in the operation of manufacture and which includes all items of indirect labor and all repairs, power, heat, light, water, etc.
4.—*Administrative Expense:* Salaries of executives, office clerks, office expenses, etc.
5.—*Fixed Charges:* Taxes, fire insurance, indemnity insurance, depreciation and interest, though the latter is not always regarded a fixed charge and often is omitted as such.
6.—*Selling Expense:* Represents all disbursements for disposing of the prod-

uct, including branches, agencies, salesmen, etc.

These six elements of cost cover all money expended except for betterments, which add to the investment value, such as new buildings, new machinery, tools and other equipment. Costs properly compiled must be classified and tabulated in accordance with the above elements.

In conclusion, let us remember the real function of a cost system is not merely to record the cost of operations, but to submit data that can be used intelligently to reduce costs; then it performs its duty and becomes the most valuable agent known to promote foundry and factory efficiency. The logical conclusion, the common sense of the condition, is that every foundry and every industrial plant needs a reliable cost system to present in an orderly manner, regularly, the facts relating to the business completely to tell the story, week by week, of the actual current business conditions with exact costs of operations by divisions and departments.

The Adaptability of Semi-Steel Mixtures*

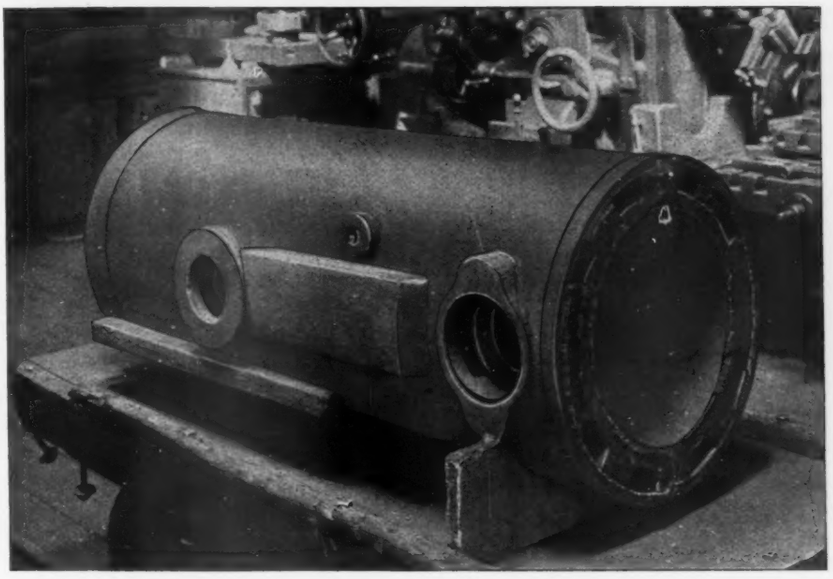
By R Hastings Probert

ALL foundries using low carbon steel with other cupola mixtures must be governed entirely by the conditions surrounding their own particular line of castings and the foundry equipment with which they have to produce the work.

In this paper the writer will state, as briefly as possible, his experience in the production of light and heavy semi-steel castings, mentioning some of the difficulties encountered and how they were overcome, and the way in which clean, solid, easily-machined castings were made.

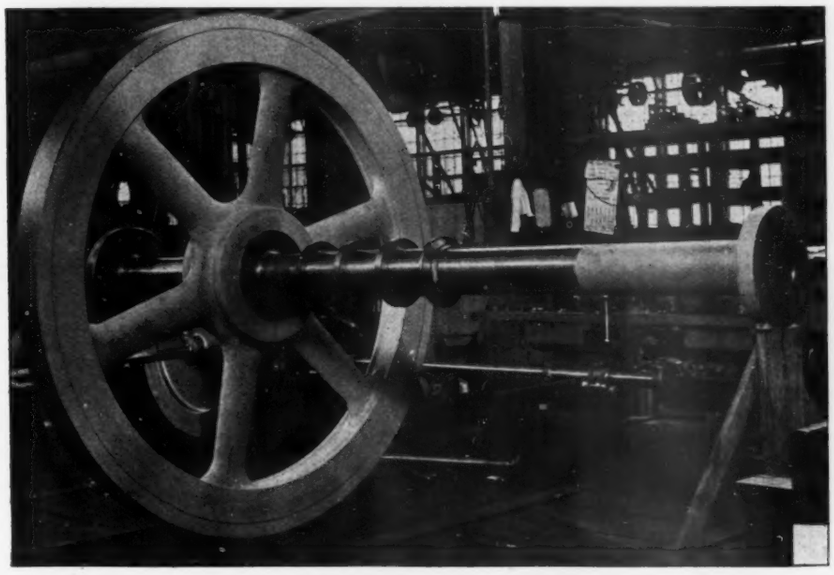
Hot Metal

One of the principal points in making semi-steel is to have the metal hot. To get the best results and to insure a thorough mixing of the iron and steel when tapping, the metal is run into the tapping ladle, which is tilted enough to run the metal into a shank or bull ladle. The latter also is tilted to allow pouring the metal into the hand or crane ladles. When melting for castings weighing from 2,000 to 8,000 pounds each, the crane ladle is of sufficient capacity to hold the entire amount of metal required, and into this ladle is placed 5 pounds of 80 per cent ferro-manganese to each ton of iron. This method of tapping permits the steel and iron to mix thoroughly in the ladles before pouring the metal into the molds.



LARGE SEMI-STEEL CYLINDER

*Presented at the May meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers, held at Springfield, O., May 22-24.



LARGE SEMI-STEEL FLY-WHEEL

In mixing metal for high grade castings that are required to stand up under high pressure and high speeds, the pig iron is charged on the bed and the steel scrap on top of this charge of pig iron. Charges amounting to 2,500 pounds each in a 40-inch cupola are as follows:

	Pounds.
Coke	1,000
Pig iron	1,000
Gray iron scrap	500
Steel scrap	500
Pig iron	500
Coke	250

The coke bed must be large enough so that the first iron will come hot.

Having tapped the metal white hot, it must be poured into the molds as nearly as possible at that heat. I do not believe in dull metal or holding back the ladle of hot metal before pouring. I do not think there is temperature enough in iron melted to warrant a delay in pouring.

We must remember that the hotter

the iron the greater should be the care taken in venting the molds, as the more resistance and refractory the mold, the more care and skill is required in feeding the hot metal into the mold. The hotter the metal is poured the more rapid is the cooling process in the mold. The temperature falls more rapidly over a large mold surface in the same time with hot metal than it does with dull metal. It is well to remember that there is greater molecular activity in molten metal, and the greater that activity the more complete is the expulsion of the gases.

Steel Scrap Used

The steel used is boiler plate scrap from ¼ to 7/16 inch thick, either square or rectangular pieces, from 6 to 18 inches long. The steel scrap is not charged directly on top of the coke bed, but, as previously stated, about 150 pounds of coke are charged on top of the steel scrap before charging the next layer of pig iron.

Careful attention is given to the charging of the cupola throughout the various heats, including the firing of the coke bed before the first charge of pig iron is placed in the cupola. By doing so, dull metal is avoided during the whole of the heats for the day's melt.

The range of analysis of the boiler plate scrap, which consists of shell, fire box and flange steel, is as follows:

	Per cent.	
Sulphur	0.022	0.038
Phosphorus	0.015	0.020
Carbon	0.12	0.18
Manganese	0.34	0.45

In 25 minutes after the blast is turned on we are ready to tap and draw off the metal; we melt about 7½ tons an hour.

Recently we cast several semi-steel fly-wheels about 9 feet, 6 inches in diameter, each weighing 7,500 pounds. These fly-wheels were for special service and required a periphery speed of 12,000 feet per minute. The wheels were successfully cast without difficulty or loss. After casting, they were machined, the hubs and rims were turned and polished. The castings proved to be clean, solid, without flaws, the metal was tough, but not hard and the turnings curled from the tool like pine shavings. The steel scrap amounted to 25 per cent of the charge. The transverse tests on a ¾-inch square bar with 12-inch supports averaged 1,625 pounds.

The analysis averaged:

	Per cent.
Silicon	1.41
Manganese	0.36
Phosphorus	0.462
Sulphur	0.122
Combined carbon	0.95
Graphitic carbon	2.46

The analysis of the pig iron charged with the gray iron and steel scrap averaged:

	Per cent.
Silicon	1.65 to 2.75
Sulphur	0.035 to 0.054
Phosphorus	0.322 to 0.754
Manganese	0.55 to 0.85

Small and medium size castings that are cored and of peculiar shape, weighing from 400 to 500 pounds each, that are required to stand up under constant high duty, are made as previously stated, showing the same analysis in the pig iron and in the finished castings.

We made gas engine cylinders each weighing about 1,650 pounds for 50-horsepower engines. These were successfully made from semi-steel. The metals charged were No. 2 foundry pig iron, gray iron scrap and the steel scrap amounted to 30 per cent of the charge. The analysis of these cylinders averaged:

	Per cent.	
Silicon	1.81	1.58
Manganese	0.51	0.56
Graphitic carbon	2.74	2.67
Combined carbon	0.78	0.72
Phosphorus	0.379	0.341
Sulphur	0.131	0.119

The transverse tests on ¾-inch square bars, with points of support 12 inches apart, averaged 1,755 pounds. The deflection amounted to 0.22 inch.

The cylinders were solid, clean and tough. They were easily machined and the bore showed excellent, smooth finish. The fractures on the test bars were fine and close grained and took a very fine finish when machined, draw-filed and polished. This was done to show up the grain of the metal.

How the Cylinders Were Made

The cylinders were poured on end, the molds were skin-dried and were provided with ample pouring basins, down gates or leaders and large risers. The shrinkage was about 3/32 inch to the foot, but on castings poured in a horizontal position the shrinkage is about 7/64 inch per foot.

We make flanges 45 inches inside diameter with about 25 per cent steel scrap. These flanges are for high duty service, all rivet holes are cored and a careful inspection after riveting them to steel tubes fails to find defects in the castings.

In making the molds the best results are obtained by working the sand as dry as possible. Do not sponge the patterns around their ends and sides, as the water will dampen the edges of the molds and will result in making the castings hard on their outside edges. It will make them too hard to machine profitably.

Provide the molds with a pouring basin and well, and do not depend on one large down gate or leader. When making medium and small work, use a strainer gate, which is a pouring basin on the top surface of the cope, with sufficient down runners of small diameter to a gate below in the surface of the drag. These runners will prevent the lighter metal and other impurities from running down into the body of the mold, resulting in clean, solid castings. Our large molds are all skin-dried, and all of the molds for semi-steel castings are provided with ample pouring basins, down runners, gates, risers, etc.

The flasks should be strongly made as the mold strain is entirely within itself and on heavy castings the flasks must be well braced and banded around cope and drag to counteract the great strains on the mold.

High grade castings are in demand by mechanical engineers in work in which cast iron is used, and it's up to the foundry management to produce them of sufficient strength and durability.

Semi-steel can be used in such castings as cylinders, pistons and plungers for steam, gas, ammonia and hydraulic work, engine and machine beds, flange couplings, bearing boxes, large flanges, brackets, pedestals, pinions and gear segments, forming dies for sheet metal, electric motor castings, etc.

It takes no more coke or labor to melt semi-steel than it does to melt gray iron. We melt daily semi-steel and gray iron, and our coke will average 1 to 7 and 7½ pounds of iron. Occasionally it will be a little below 7 pounds, but this must be expected on short heats and low tonnage. It is not good foundry practice to risk losing an expensive casting so as to save a few pounds of coke.

We find that our castings are greatly improved by the use of soft steel scrap as we have greater strength and wearing surface, and the increased strength permits a decrease in section and weight of castings. In making our semi-steel castings we incurred no additional expense for equipment. The writer proceeded with the same equipment and conditions that prevailed daily in our gray iron foundry, and when making semi-steel it is melted and poured off first, following with the gray iron.

American Electro-Platers' Society

The name of the National Electroplaters' Association of the United States and Canada has ben changed to the American Electroplaters' Society. Officers of this organization recently elected follow:

President, George B. Hogaboom, Newark, N. J.; first vice president, J. H. Hansjosten, Chicago; second vice president, W. S. Barrows, Toronto, Can.; secretary, F. C. Clement, Philadelphia, and treasurer, John J. Schultz.

French Molding Machines for Shallow Work

A New Type of Machine, Built in Two Styles, Which is Being Adapted Extensively in Europe for the Manufacture of Light Castings

A NEW type of power-operated molding machine, adapted especially for shallow work, such as light hardware, stove plate, ornamental castings, etc., now is being built by Ph. Bonvillain & E. Ronceray, Paris, France. In the operation of this machine both the cope and drag flasks are filled with sand simultaneously, the two parts of the mold being rammed by one stroke. The pattern is drawn by the machine while the pattern plate is being vibrated. The mold is closed on the machine either for pouring flat or on end. Barred flasks can be used and a white metal pattern plate, about ½ inch in thickness, can be employed, which requires no further machining after being cast and can be made in approximately the same time as that required for producing a sand match.

This machine is designed especially to eliminate fins on light work, which result from the improper matching of the cope and drag halves of the mold. It is practically impossible to remove these fins by tumbling and the cost of grinding, in most cases, is too expensive on light work. The pattern plate employed on this machine is cast in a carefully made mold and in a special flask provided for this purpose which has a perfect match. The pattern plate is outlined in the mold by a frame. While the mold is being rammed on this machine, the pattern plate is without lateral fastenings, being guided only by the flask pins. Since barred flasks can be used, flasks comparatively shallow can be employed for molds even of large size and this eliminates the necessity of weighting the molds for pouring in a horizontal position or the use of clamps when pouring on end.

Most of the operations are effected by hydraulic pressure, although the pattern plate is vibrated by compressed air. However, by the use of a small intensifier compressed air can be utilized to effect all of the necessary mold-making operations. This machine is illustrated in Figs. 1 to 6 and consists of a base, *A* Fig. 2, bored in the center to form

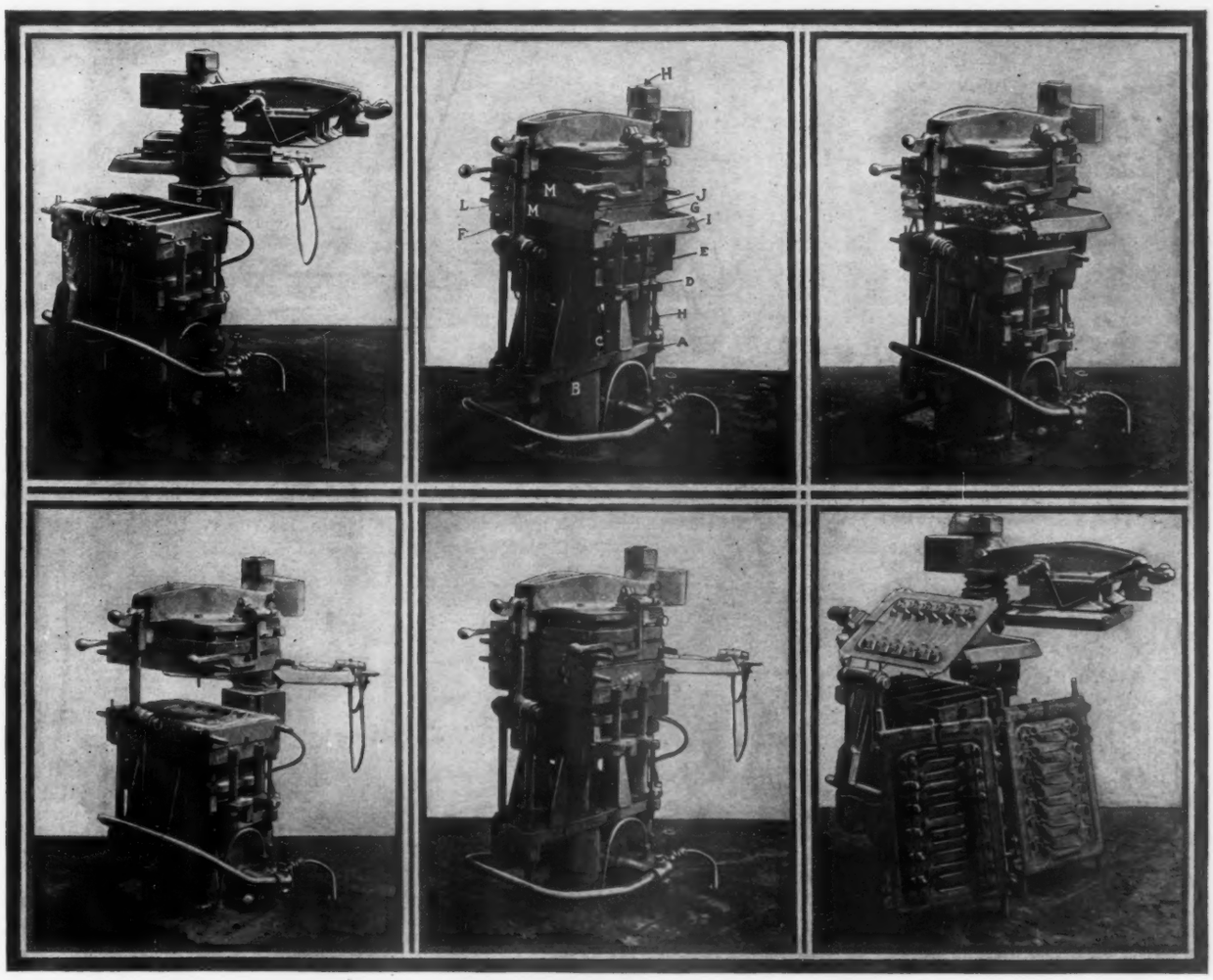


FIG. 1—FLASKS IN POSITION BEFORE FILLING WITH SAND

FIG. 2—RAMMING THE MOLD

FIG. 3—DRAWING THE PATTERN

FIG. 4—PATTERN PLATE SWUNG ASIDE

FIG. 5—CLOSING THE MOLD

FIG. 6—DRAG AND COPE HALVES OF THE MOLD

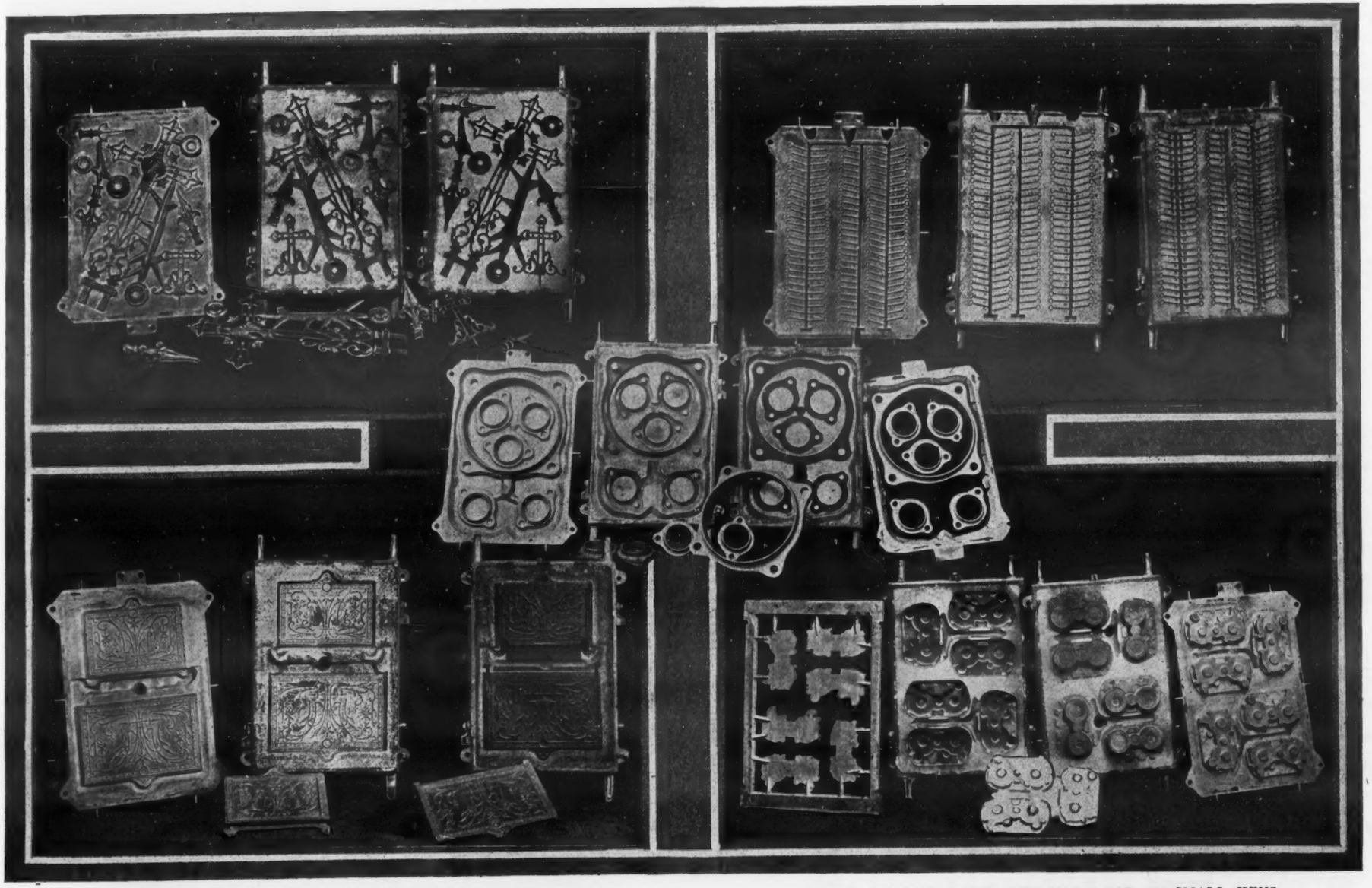


FIG. 7—PATTERN PLATE AND MOLD FOR ORNAMENTAL CASTINGS

FIG. 8—PATTERN PLATE AND MOLD FOR 104 SMALL KEYS

FIG. 9—PATTERN PLATE, MOLD AND DUMMY

FIG 10—PATTERN PLATE AND MOLD FOR ORNAMENTAL STOVE PLATE

FIG. 11—DUMMY, MOLD AND PATTERN PLATE FOR ALUMINUM CRANK CASE

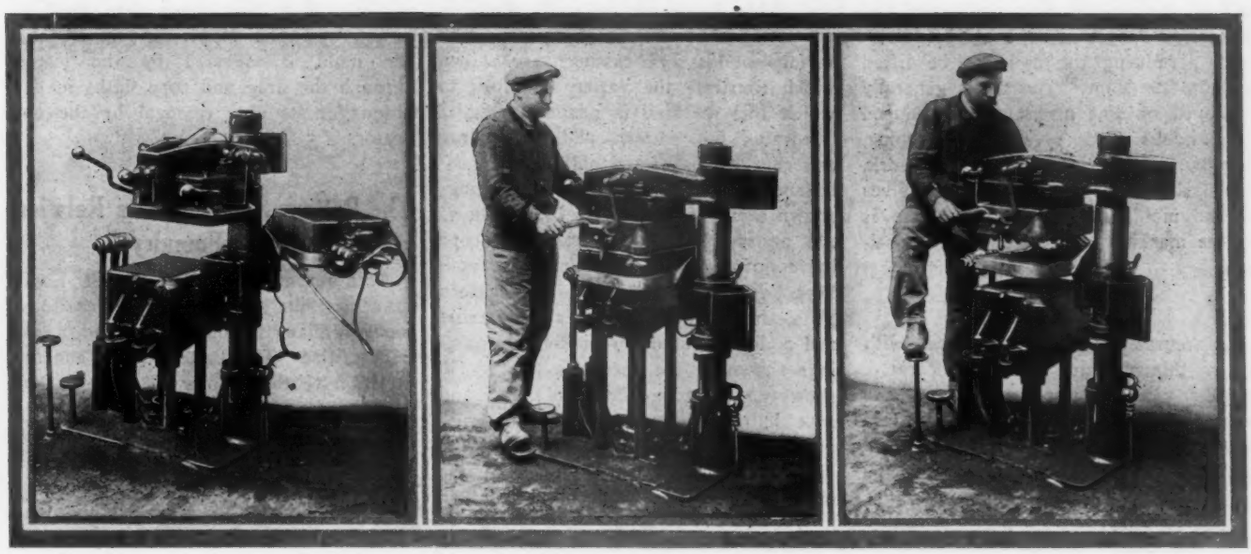


FIG. 12—FLASKS FILLED WITH SAND

FIG. 13 — RAMMING COPE AND DRAG HALVES OF THE MOLD SIMULTANEOUSLY

FIG. 14—DRAWING THE PATTERN

the ramming cylinder, *B*. A smaller cylinder is located inside of the larger cylinder which performs all of the auxiliary operations, such as closing the mold in its upward movement, and it is bored to receive the small cylinder at the end of which is bolted a plate, *D*, that supports, through tie-rods, *E*, the lower sand frame, *F*, underneath the lower flask, *G*. The smaller piston is operated by compressed air and its purpose is merely to support the sand frame, *F*. At the side of the machine is a column, *H*, which supports a revolving bracket, *I*, for the pattern plate, *J*, and a cross beam which is clamped, as shown in Fig. 2. The pattern plate, *J*, is supported by the bracket, *I*, and can be raised through the lower flask.

When operating the machine, the cross beam is swung to the right and the pattern plate with its bracket is turned in the opposite direction, as illustrated in Fig 1. One of the operators fills the drag with sand and the other operator fills the cope. The drag flask is laid on the lower sand frame and the cope flask is placed in position on the pattern plate. The cope operator then swings the bracket into position over the drag, while the drag operator swings the cross beam and clamps it in position, as illustrated in Fig. 2. The drag operator then admits water into the small cylinder by depressing a treadle provided for this purpose and the entire equipment is lifted, the pattern plate and the cope being held stationary until the cope comes in contact with the upper ramming plate. In the meantime, water is admitted to the main cylinder and by further depressing the treadle, the ramming of the mold is effected. The cope operator next sets the vibrator in motion, the drag operator clamps the cope in position while the drag is lowered with the pattern plate, as illustrated in Fig. 3.

The descent of the pattern plate is stopped when it contacts with its supporting bracket, while the drag continues its descent until the pattern-drawing operation is completed. The cope operator then stops the vibrator and swings out the bracket containing the pattern, as illustrated in Fig. 4. The drag operator then depresses the treadle, which admits water to the small cylinder, thereby effecting the closing of the mold, as illustrated in Fig. 5. The cope

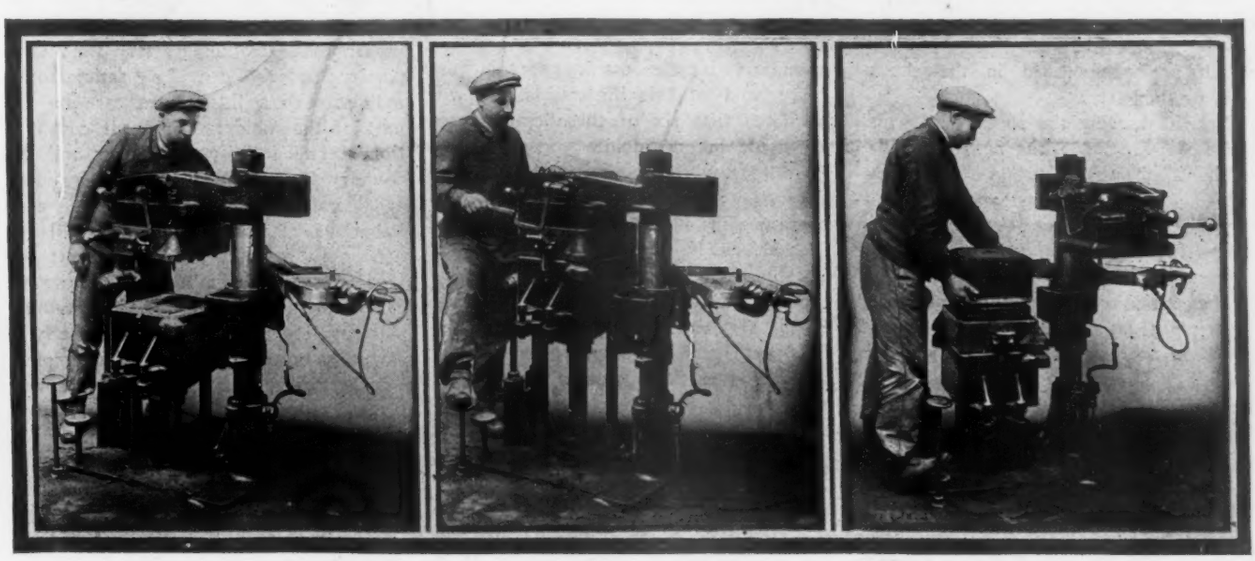


FIG. 15—PATTERN PLATE SWUNG ASIDE

FIG. 16—CLOSING THE MOLD

FIG. 17—MOLD ELEVATED FOR LIFTING OFF

half of the mold then is unclamped and the piston supporting the mold is lowered, permitting the mold to be lifted off onto the floor. The flasks generally employed on this machine are equipped with hooks and eyes for clamping, thereby greatly facilitating this work. Fig 6 shows the drag and cope halves of the mold, and the pattern plate is on the machine in a slightly tilted position.

Speed of Operation

To accurately ascertain the speed with which this machine can be operated, moving pictures were made and the period of time for producing a mold by two operators was 45 seconds. These pictures made it possible to analyze the various movements of the operator, which are summarized in the accompanying table.

Molding Machine Operations

MOLDING DRAG AND COPE; FLASKS 21½ x 14½ INCHES AND 2¾ INCHES DEEP

Movements of operator.	Sec.	Fractions of min.	Movements of helper.	Sec.	Fractions of min.
Picks up drag and puts it in place	1.9	0.032	Blows off pattern plate.		
Fills drag, 2 shovelsful and puts sand in riddle	6.4	0.107	Swing sand frame above cope, shakes parting and riddle sand on pattern	10.4	0.174
Riddles sand on drag top.	9.0	0.150	Fills cope, 2 shovelsful of sand	6.9	0.115
Strikes off surplus sand	4.5	0.075	Strikes off surplus sand	4.5	0.075
Swings the pressing head and locks it	1.8	0.030	Swings pattern plate with cope on	7.4	0.123
Squeezes and hooks cope.	5.5	0.090	Starts vibrator	5.6	0.056
Draws pattern plate and finishes gate holes with fingers	7.7	0.130	Swings out pattern plate and puts on cope	3.9	0.065
Applies pressure to close mold and unhook cope.	1.9	0.031	Locks finished mold	1.8	0.030
Releases pressure springs out pressing head and locks finished mold	1.8	0.030	Places mold on floor, on end	4.5	0.075
Places mold on floor on end	4.5	0.075	Total	45.0	0.750
Total	45.0	0.750			

No. 7 riddle.	Pounds.	No. 7 riddle.	Pounds.
Weight of an empty shovel	6	Weight of an empty shovel	6
Weight of sand in shovel	22	Weight of sand in shovel	22
Two shovelsful in each part of flask	44	Two shovelsful in each part of flask	44
Weight of sand in the two parts of flask			88
Weight of the two empty parts of flask			82½
Total weight			170½

Notwithstanding the speed with which the molds are made, the flasks are filled by hand, no sand distributor being employed. During the past year, 45 molding machines of this type have been placed in operation in various foundries in Europe.

The difficulty frequently experienced in printing flat work, to a large extent, has been overcome by a device which is termed a dummy by Ph. Bonvillain & E Ronceray. It is shown at the right, Fig. 9, and contains openings corresponding to the projections in the mold to be made. The dummy is placed in the drag half of the mold on top of which sand is riddled and the projections of sand are left at the points corresponding to the openings in the dummy. This device can be easily made in any foundry. In Figs. 7, 8, 9, 10 and 11 various molds and castings are shown which illustrate the variety of work to which this machine is adapted. Fig. 7 illustrates the pattern plate and drag and cope halves of a mold for the miscellaneous lot of ornamental castings shown in the foreground. Fig. 8 shows the pattern plate and drag and cope halves of a mold containing 104 small keys. Fig. 9 is a view of a pattern plate, drag and cope halves of a mold and a dummy used for making the castings shown in the foreground. Fig. 10 shows the pattern plate and drag and cope halves of a mold for two ornamented stove doors. Fig. 11 shows the dummy, drag and cope halves of the mold and the pattern plate for an aluminum bicycle crank case in the foreground of this illustration. It will be noted that six of these crank cases are made in one mold.

Another machine, similar to the type shown in Figs. 1 to 6 and which can be operated by one man is illustrated in Figs. 12 to 17. Molds 16 x 12 inches can be made in an average period of slightly less than one minute. In Fig. 12 the cope and drag flasks have been filled with sand, the cope resting on the bracket over the pattern plate and being swung aside. In Fig. 13 the operator is simultaneously ramming both halves of the mold and in Fig. 14 the pattern is being drawn, the drag being lowered while the pattern plate remains supported on the swinging bracket. In Fig. 15 the pattern plate is swung aside to permit of closing the mold, as shown in Fig. 16. The upper arm then is swung aside, as shown in Fig. 17, and the mold is elevated by the piston through the drag and cope flasks in position for its easy removal by the operator.

The Pattern Shop and Its Relation to the Foundry

At a recent meeting of the St. Louis branch of the Associated Foundry Foremen, William Hommel presented a paper entitled "The Pattern Shop and Its Relation to the Foundry." In part Mr. Hommel's paper follows:

"Up-to-date pattern shops should be equipped with the best possible machinery that can be obtained and the various tools should be so arranged that the patternmaker will lose the least possible time in walking from one machine to the other. For example, the cut-off or band saw should be close to the lumber rack and the rip saw, jointer and surface planer should follow in the order named. The best possible material should be purchased for making the patterns, which includes lumber, shellac, glue, etc. For all rough work and one or two casting jobs, an inferior grade of lumber should be kept in stock. Also, many patterns can be made in plaster and wax that would require much more time to produce in wood. This applies principally to patterns for architectural work.

"When the word *harmony* is applied to the relations existing between the pattern shop and foundry it follows that there is a minimum of friction between the two departments and a maximum of output. The patternmaker should not slight his part of the work, thereby causing trouble for the molder, and, on the other hand, the molder should not expect the patternmaker to devote unnecessary time to a pattern which can be satisfactorily molded with a little extra care on the part of the molder. Frequent consultations between the patternmaker and the foundry foreman will result in avoiding considerable unpleasantness. A conscientious patternmaker usually will endeavor to make a pattern to meet the requirements of the molder. However, care should be exercised in handling patterns, as it seems that frequently a sledge hammer is employed for rapping. Another great fault I find is the way many molders use their swabs. A wood pattern, regardless of the number of coats of shellac applied, will soon warp as a result of the too liberal use of the swab.

"The cost of the castings should always be carefully considered by the foremen of both departments."

Study of Bearing Metals and Testing Methods*

Results of an Investigation of Tin-Base and Lead-Base Bearings, With Interesting Details on Melting and Pouring Babbitt Metals

By T D Lynch

ONE does not have to go very far into the study of materials for use in the construction or maintenance of machinery until the question of the proper bearing material is presented. Shall it be made of solid bronze or shall it be made of a bronze or cast iron shell lined with babbitt? If the latter, what shall the composition of the lining be and how can it be tested?

The discussion following will be confined primarily to the babbitted type of bearing with special reference to the importance of proper heat treatment in order to produce a good babbitt and further to the description of certain tests that have been made in connection with the study of the subject.

Elimination of Tin

The introduction of lined bearings dates back to Sir Isaac Babbitt, who first used a composition containing approximately 90 per cent of tin, the remainder being copper and antimony. This babbitt is sometimes known as "Genuine A-1", and when properly made is tough, hard, has a low melting point, good anti-frictional qualities and is more nearly fool-proof than any other babbitt in use. It has, therefore, become a valuable standard for the comparison of quality. However, the price of tin has become so high (approximately 50 cents per pound), that

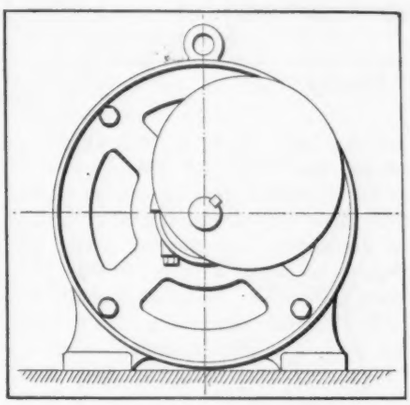


FIG. 1—BEARINGS MOUNTED ON TEST MOTOR

the problem of a substitute for the A-1 babbitt has become of great commercial importance; so much so that almost every conceivable formula of tin, lead, antimony, copper, zinc and nickel have been suggested and many of them tried in service as a substitute for the A-1. Some of these have met with success while others have met with marked failure. This infinite variety of possible compositions, together with varying temperatures and hit-or-miss methods of handling the material has produced innumerable variations in the efficiency of the product.

Both laboratory and service tests have shown that good results may be had with the lead-base as well as the tin-base babbitts, so the problem reduces itself to a study of the conditions necessary to produce certain anti-frictional and mechanical qualities, and of the methods of testing for them.

Babbitt Metal Tests

During recent years we have been conducting a series of tests in the laboratories and works of the Westinghouse Electric & Mfg. Co., at East Pittsburgh, for the purpose of determining some reliable yet practical test that would indicate the essential qualities and give a check on the materials used and on the method of manufacture, by means of which we may learn *why* a certain babbitt should be used, *how* it should be treated, and *what* it will do when completed and in service.

The first test was conducted on a

*Presented at the annual meeting of the American Society for Testing Materials, held at Atlantic City, June 24-28.

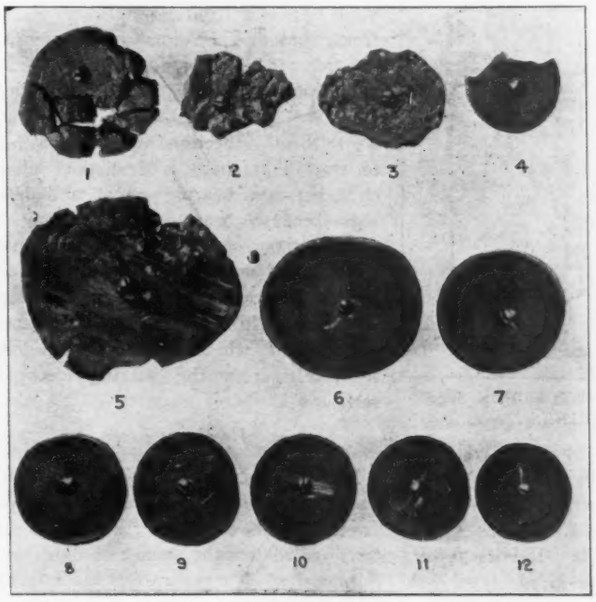


FIG. 2—LEAD-BASE SAMPLES SUBJECTED TO VARIOUS TESTS

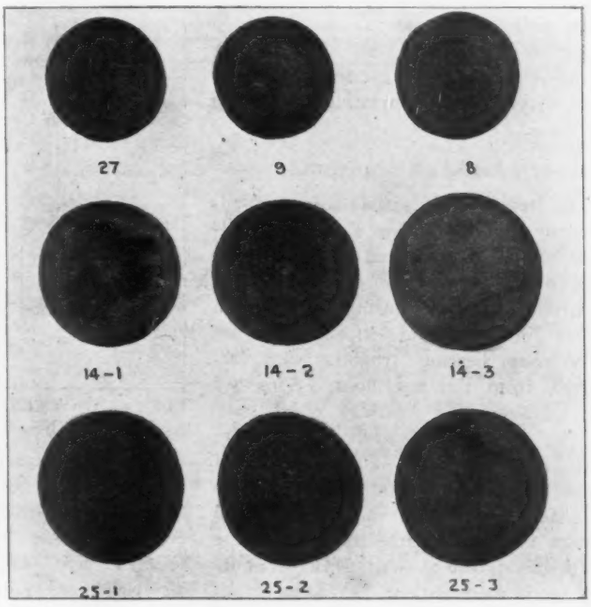


FIG. 3—TEST PIECES MADE FROM FIVE DIFFERENT BEARING ALLOYS

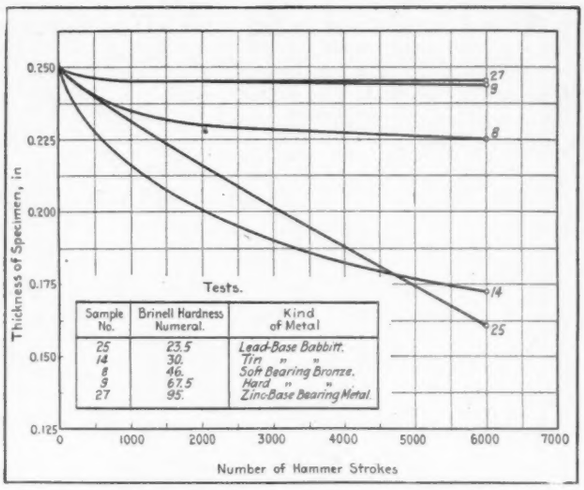

Thickness of Specimen, in
Number of Hammer Strokes
Tests.
Sample No. | Brinell Hardness Numeral. | Kind of Metal
25 | 23.5 | Lead-Base Babbitt.
14 | 30. | Tin " "
8 | 46. | Soft Bearing Bronze.
9 | 67.5 | Hard " "
27 | 95. | Zinc-Base Bearing Metal.

FIG. 4—CURVES SHOWING EFFECT OF TEMPERATURE ON BABBITT METALS

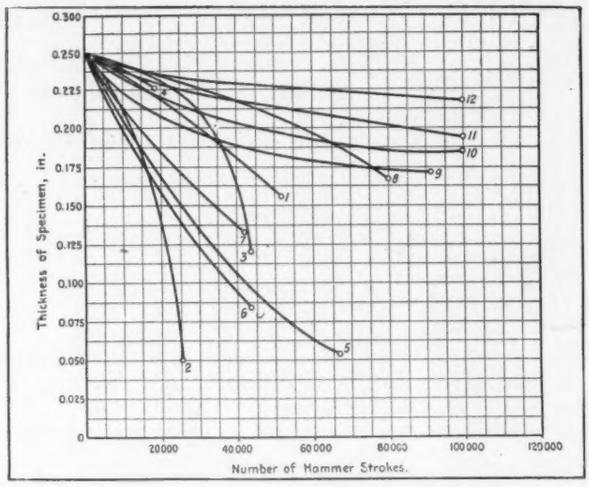


FIG. 5—COMPARATIVE CURVES OF BABBITT AND BRONZE BEARING METALS

friction testing machine, the results of which were not conclusive in that they could not be duplicated from day to day even on the same test sample. The experiences of others were then sought and among them the late Dr. C. B. Dudley was appealed to for a reliable friction test. He replied that he had tried all known laboratory tests and semblance of tests, to be convinced that only the service test could so far be relied upon.

We next turned our attention to a practical service test on motors operating under severe shop conditions. Ten motors were selected for the test. They were of varied sizes, but all had cast iron shells lined with tin-base babbitt metal. The bearings were all replaced with other bearings lined with the lead-base metal carefully and properly made. In every case the lead-base lining stood up as well and in some cases better than the tin-base lining—the severe conditions under which they were operating remaining the same.

Lead-Base Bearings

This test was so satisfactory and apparently so conclusive that the lead-base metal was adopted for the bearings of a certain line of motors and accordingly manufacturing was begun under normal shop supervision, but very soon bearing troubles were reported from the test floor. Some of the relatively few bearings which gave trouble were brittle while others were soft and wiped out. The existence of these opposing characteristics of failure in a few bearings, in spite of the good results found in a large majority of the bearings on test as well as under normal service conditions, gave us much concern, and the difficulties encountered shattered the faith so far placed in the lead-base metal, because it was not entirely clear as to what had caused the occasional failure.

To determine the underlying causes for these varied characteristics a test to destruction was planned. With this object in view a test bearing was made from a lead-base metal but under careful supervision; each bearing was measured accurately, each set of measurements including five diameters equally spaced at each end and at the middle of the bearing. The bearings were then mounted in a test motor as shown in Fig. 1. The motor selected was of the 15-horsepower, direct-current, variable-speed type. A 265-pound weight was mounted eccentrically on the pulley end of the shaft. The motor was run at speeds increased by easy steps until the limit of the motor frame was exceeded and the frame destroyed; yet the bearing remained in good condition.

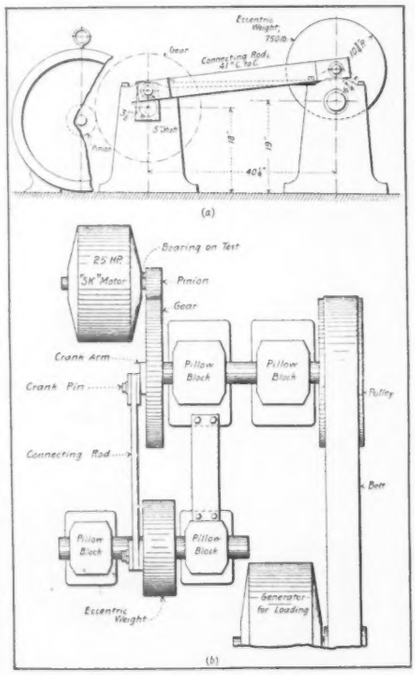


FIG. 6—ANOTHER DEVICE FOR TESTING BEARINGS

A second test was planned using the same bearing and a 25-horsepower motor arranged as shown in Fig. 6 (*a*) and (*b*). This motor was back-geared to a countershaft to which in turn was coupled an arm driving an eccentric weighing 750 pounds; thus producing a shock similar to the effect found in the operation of a rock crusher. A generator was belted to the same countershaft in order to load the motor in the test. The motor was run light for several days with shock effect only. It was then loaded by steps until an excessive overload was reached, which in addition to the continual shock caused by the eccentric produced a condition much more severe than is allowable even in extreme practice. Yet with all this the bearing remained in good condition and check measurements showed negligible wear.

In this connection it may be well to state that there is a distinct difference between bearing metal and bearings because bearing trouble may be due to many causes not inherent in the metal, such as defective alignment, improper lubrication, insufficient clearance, sand in oil, abnormal belt pull, etc., all of which must be considered separately from the bearing metal itself.

Hardness Test

No definite measure of quality could be deducted nor conclusions drawn from the above tests, therefore, other tests were sought which would give a measure of comparative value. The Brinell test was next tried as follows: A 500- kg. weight on a ball 10 mm. in diameter for a period of 30 seconds

was used. The sample was poured into an open steel mold, 2 inches in diameter and 5/8 inch deep, previously heated to about 150 degrees Cent. Before making the impressions the specimens were faced off, removing just enough metal to even up the two flat surfaces. The Brinell test was then made on the bottom end of the specimen at three equally-spaced points on a circle one-half the radial distance from the center. An average of the three readings was recorded as the hardness of the metal. A Brinell hardness numeral of 30 for tin-base and 23.5 for lead-base metal was found to give excellent results, other things being normal; but this test did not reveal the whole story, since it failed to differentiate between toughness and brittleness.

Hammer Test

A further test was found to be necessary in order to detect and study these two characteristics, so a hammer test was devised which has shown results that indicate the qualities of the babbitt more clearly and definitely than any other quick test. The test specimen if soft peens out, if brittle it breaks, while if soft and brittle it peens out and crumbles.

This test resembles the most severe service condition with the wiping action left out and is introduced here as worthy of the most careful consideration, and the many tests made have proven it to be extremely useful in giving a measure of brittleness and toughness. When used in combination with the Brinell test we have no difficulty in detecting defective babbitt metals.

A series of hammer tests was inaugurated with special reference to the comparative qualities of the lead-base and the tin-base metals. These tests included a great variety of heat treatments and methods of handling the metal and their results emphasized the favorable possibilities of the lead-base metal, but also showed clearly that the temperature of both the smelting and pouring of the metal must be kept within narrow limits.

The samples for test were made as follows:

The metal was poured into a metal mold producing a rough casting 1¼ inches in diameter by 7/16 inch thick, which was then turned to 1 inch in diameter by ¼ inch thick. The turned sample was placed on the anvil of the testing device and the hammer set in motion. Readings were taken at frequent intervals, observing thickness of sample and number of strokes, from which curves were plotted.

Samples were taken from the kettles where the different alloys were being smelted from stock ingots remelted in a hand ladle and from various babbitting pots. A careful record was made of all conditions that might affect later results, including the temperature and general condition of the metal, as well as the temperature of the molds into which they were poured. The results of the tests on these samples demonstrated clearly that some were hard and brittle, some soft and brittle and others soft and plastic, while still others were hard and tough. The tin-base samples showed much less variation than the lead-base although some of the very best results obtained were from the lead-base metal. These observations and tests further indicated that smelting and pouring temperatures, especially of the lead-base metal were of prime importance.

The following detail study of the lead-base metal was then made on material known to be of good quality before subjecting it to different temperatures. The results are shown in Figs. 2 and 4. The samples are numbered 1 to 12.

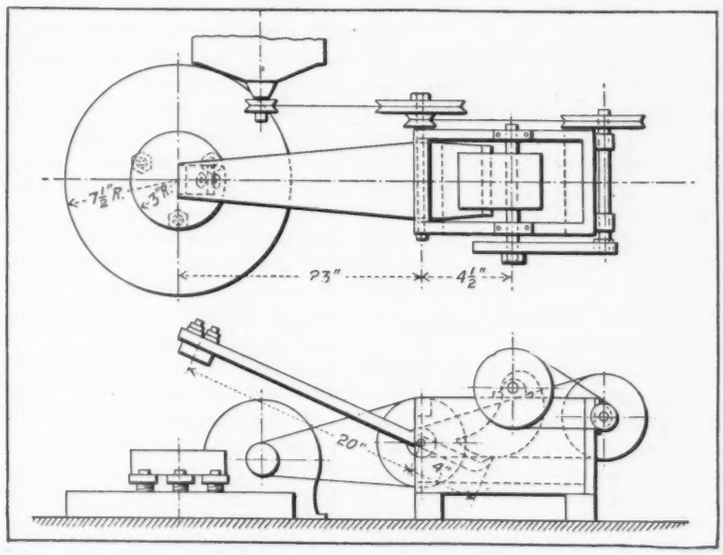


FIG. 7—HAMMER TESTING DEVICE FROM WHICH DATA FOR CURVES, FIG. 4, WERE MADE

No. 1 was poured at 320 degrees Cent. Note the granular and brittle condition of the metal due to having been poured too cold.

No. 2 was poured at 700 degrees Cent. Note the unstable character of this sample due to having been poured too hot.

No. 3 was heated to 700 degrees Cent., allowed to become cold, then reheated to a similar temperature many times and finally reheated and poured at 400 degrees Cent. This sample was also unstable due to repeated overheating, even though poured at a proper temperature.

No. 4 was heated to 550 degrees Cent. and allowed to become cold, then reheated to a similar temperature many times and finally reheated to about 490 degrees Cent. and poured. Note the brittleness due to repeated overheating, even though the temperature was only slightly higher than that necessary for the pouring of good bearings.

No. 5 was heated to 700 degrees Cent. and cooled to 400 degrees Cent. before pouring. Note the softening effect due to the single overheating.

Nos. 6 and 7 were poured at 360 degrees Cent. Both show a decided improvement over No. 1, but were poured at too low a temperature to produce the proper hardness and toughness necessary for a good bearing.

No. 8 was heated quickly to 600 degrees Cent. and poured at once. Note that very little damage was done by the one overheating.

No. 9 was heated similarly to 600 degrees Cent. but cooled to 460 degrees Cent. before pouring. Note the difference in shape of curves Nos. 8 and 9, Fig. 4.

Nos. 10 and 11 were poured at 480 degrees Cent. and No. 12 was poured at 460 degrees Cent.; all were hard and tough, giving curves characteristic of a good babbitt.

A large number of tests, not here shown, were also made on babbitts of a great variety of composition for the purposes of comparison. The tin-base babbitt curves were practically all found to be within the limits shown by Nos. 10, 11 and 12 of Figs. 2 and 4. No babbitt tested gave better curves than those made from the lead-base metal when carefully and properly made, thus demonstrating the possibilities of the lead-base metal.

This series of tests was so con-

clusive as to the importance of temperature limitations that a temperature regulator was designed and installed on each babbitting pot. These regulators were so adjusted and safeguarded as to render it impossible for the temperature of the babbitt in the pot to exceed a fixed limit.

It has been found to be entirely practical to automatically regulate the temperature of the metal in the pot so that the variation from a fixed point need not be more than plus or minus 10 degrees Cent., and this variation is well within the range of safety for the lead-base as well as the tin-base metal.

The hammer testing device shown in Fig. 7 on which data for the curves of Fig. 4 were made proved so interesting and instructive that an improved drop-hammer was designed and built. This hammer has a stroke of 1¾ foot-pounds, but the anvil is heavy thus resulting in similar curves to those of Fig. 4, but requiring only about five per cent of the number of strokes, and a correspondingly shorter length of time for the test than was required on the device shown in Fig. 7.

All of the more recent tests have been made under the new hammer, and Figs. 3 and 5 are introduced to illustrate characteristic hammer test curves and appearance of test pieces made from five different bearing alloys under normal conditions.

These tests represent a few of a long series of tests made in connection with commercial work with special reference to the following features: Raw material used, smelting and refining in the crucible or kettle, Brinell hardness of standard samples of the ingot as poured, remelting and pouring temperatures at the babbitting pot, temperatures of the shells into which the metal is poured, Brinell tests and hammer tests taken from the babbitting pots at frequent intervals, and to a limited extent the microscopic structure of babbitt known to be good as well as that known to be defective.

Conclusions

The conclusions drawn as a direct result of these tests, together with a large amount of service experience, may be summarized as follows:

1.—The number of compositions of babbitt metals should be as few as possible, preferably one of the tin-base and one of the lead-base and each should be made the best of its class.

2.—The constituent metals must be of superior grade, carefully tested and inspected, since the first requisite is a good raw material.

3.—The alloying or smelting is of vital importance and must be so done that the high and low melting-point metals may be properly alloyed far below the melting-point of some of the component parts. A temperature of 500 degrees Cent. and less has been found to be sufficient to obtain satisfactory alloying of babbitt metal. The melted metal should at all times be kept covered with powdered charcoal or other protection from oxidation.

4.—Pouring the babbitt too cold tends to produce a granular or coarse crystal formation and pouring it too hot tends to produce a softening effect. The lead-base babbitt is not nearly as fool-proof as the tin-base, and, therefore, the range of pouring temperature is more limited. However, a pouring temperature of 460 degrees Cent. (450 to 470 degrees Cent.) for both lead-base and tin-base babbitts has been found to give excellent results.

5.—Heating the shell to 100 to 150 degrees Cent. before the babbitt is poured into it tends to prevent blow-holes and similar defects and also prevents the lining from shrinking away from the shell.

6.—Babbitted bearings must not be jarred while the metal is solidifying since any disturbance at this temperature tends to enlargement of the crystals and corresponding brittleness.

7.—The matrix of the lining metal should be just stiff enough to support the hard crystals. These hard crystals should be as numerous as possible and yet not lie on each other to cause brittleness.

8.—A Brinell hardness of 23.5 for lead-base and 30 for tin-base babbitts has been found to give excellent results.

These tests and suggestions are offered simply as a study to be furthered by those interested in applying babbitted bearings to their several service conditions; and while no final decision can be reached as the result of these tests, they certainly do emphasize the great importance of working closely to given compositions, and of following definite processes checked by chemical tests, Brinell tests, hammer tests, careful supervision, and finally by the court of last resort, service.

Testing Engineers Discuss Copper and Alloys

AT THE annual meeting of the American Society for Testing Materials, held at Atlantic City, June 24 to 28, the sub-committee on pure metals in ingot form classified American copper as electrolytic, lake and casting. Revised specifications for electrolytic copper were presented and a separate specification for lake copper in two main classes was drafted. The situation regarding casting copper was carefully canvassed and at first it was thought possible to subdivide this into virgin and reclaimed copper, but no way has been found to reconcile the great differences in composition of casting copper sold in the American market with the corresponding values and uses.

After electrolytic and lake copper had been disposed of, the committee reported that there are three sources of more or less impure copper which are marketed as casting. These include fire-refined copper from virgin sources, copper electrolytically-produced by deposition from impure liquors, and copper reclaimed from secondary sources.

Virgin Casting Copper

The virgin casting copper corresponds in a general way to the fine copper produced in many parts of the world before the days of electrolysis. Its principal characteristics are resistivity too great for modern electrical uses and small quantities of more or less innocuous impurities, the copper content being quite high, namely 99.80 per cent or over.

The second source of casting copper, namely electrolytic precipitation from impure liquors, is irregular. In electrolytic refining, a certain proportion of the output varying from nothing to 2 per cent, has to be recovered by use of insoluble anodes, due to chemical solution of part of the copper as distinguished from electro-chemical solution. As copper electrolytes invariably carry arsenic and other impurities, a contaminated cathode is produced on account of the high working voltage, which is two volts or over in a tank of this kind. At one time this material was made into casting copper, but as it was difficult to market it on account of the quantity and grade, it has been largely suppressed by refining, crystallization as bluestone, or in other ways. The copper content varies from 97.5 to 99.5 per cent.

The third source of casting copper,

namely reclaimed copper, is large in quantity. In quality it generally is an alloy, carrying tin and nickel as the main impurities and it has no fixed composition. An ordinary average would be about 99.25 per cent copper, but 98.5 would not be unusual. The impurities, however, frequently are a distinct advantage in foundry work, as a little tin generally improves the properties of the castings. The source of the product is mainly miscellaneous copper-bearing material derived from the manufacture of brass and bronze. This usually is collected by scrap dealers and is sold to refiners, who largely eliminate the zinc, lead and iron which such waste carries.

Summarizing the Results

In summarizing the results of its deliberations, the committee stated that all that can be said of casting copper is that it is not reasonable to expect either low resistivity or any considerable ductility from such material. As its name implies, it is exclusively a foundry copper. The copper contents are variable, the better known brands containing over 99 per cent and in some cases of virgin copper an assay of 99.9 per cent is maintained regularly. As long as the copper is clean, free from slag or dirt, and shows good fluidity when melted, but little objection can be made to the particular impurities which may be present.

In conclusion, the committee stated that it is impossible to draw up a specification which can be acceptable at the same time to all of even the larger producers and consumers of what is nevertheless a distinct class of American copper. If the consumer is interested in obtaining certain results possibly connected with the particular impurities present, he should familiarize himself with the assay of the particular brands with which he has had success and insist upon uniform delivery. If he is buying casting copper at a price far below electrolytic, he must realize that the copper contents must be low or it would have paid the producer to have the copper electrolytically-refined. A great deal of the consumption is by small brass foundries where testing facilities are limited and consequently specifications are not likely to be given special attention.

The sub-committee on copper casting alloys reported that its work was confined to the revision of the present specifications for manganese bronze, and certain changes were recommended in the composition. On account of the fact that the present method of taking test specimens is not satisfactory, it was decided to let the present specification stand and to refer it back to the sub-committee for complete revision.

The sub-committee on white metals has commenced the investigation of five alloys, which represent the most widely used babbitt metals in service. The series of alloys investigated were as follows:

No. 1.—Tin, 89 per cent; antimony, 7 per cent, and copper, 4 per cent.

No. 2.—Tin, 83.33 per cent; antimony, 8.33 per cent, and copper 8.33 per cent.

No. 3.—Tin, 50 per cent; antimony, 12 per cent, copper, 1 per cent, and lead, 37 per cent.

No. 4.—Tin, 7 per cent; antimony, 17 per cent, and lead, 76 per cent.

No. 5.—Antimony, 10 per cent, and lead, 90 per cent.

It was decided that the committee's work for the present should be confined to the study of the properties of these various alloys and the determining of the most satisfactory method of sampling and analyzing. With this end in view, analyses were made by five members of the committee, all using the methods which are standard in their respective laboratories. Owing to the variation in the results obtained by some members of the committee, the work probably will be repeated.

The Brinell hardness tests and the compression tests were equally unsatisfactory, and it was found that a standard method of making these tests would have to be formulated. Furthermore, it was considered advisable to rearrange the series of alloys in respect to their hardness, from one to five, so that the five alloys would satisfactorily cover the range for all requirements, thereby eliminating the slight variations which are at present made in the five standard types suggested. It was thought that a satisfactory rearrangement of the series would be as follows:

No. 1.—Tin, 83.33 per cent; antimony, 8.33 per cent, and copper, 8.33 per cent.

No. 2.—Tin, 89 per cent; antimony, 7 per cent, and copper, 4 per cent.

No. 3.—Tin, 50 per cent; antimony, 15 per cent; copper, 2 per cent, and lead, 33 per cent.

No. 4.—Tin, 5 per cent; antimony, 15 per cent, and lead, 80 per cent.

No. 5.—Antimony, 10 per cent, and lead, 90 per cent.

As the standard method of sampling and analysis is of prime importance, it was the belief of the committee that this is the first question which should be settled, and the co-operation of the Bureau of Standards has been asked to aid in producing a new series of samples, all taken in precisely the same manner and in accordance with an agreed method. It is believed that during the next year the work of the committee will have progressed to such a point that recommendations can be made for satisfactory specifications covering babbitt metals as follows:

1.—Recommendation of five, or perhaps six or seven, standard formulas which will cover the entire range of requirements for babbitt metals, with variable limits on each constituent and stipulation of maximum impurities.

2.—Standard methods of sampling.

3.—Standard methods of analysis.

4.—Recommendation for proper heat treatment and method of manufacture.

5.—Physical tests which will show whether the alloy has been properly prepared and subjected to correct heat treatment.

In the standard specifications proposed for lake copper, lake copper wire bars, cakes, slabs, billets, ingots and ingot bars, it was provided that to be classed as lake, copper must originate on the northern peninsula of Michigan. The grades were divided into low resistance lake and high resistance lake.

The proposed standard specifications for electrolytic copper provide for purity of at least 99.88 per cent, as determined by electrolytic assay, silver being counted as copper.

Piston Rings

By W. J. Keep

Question.—We would like to have a good mixture for piston rings. They are 5/8 to 7/8 inch in thickness, but after they have been cut, the edges remain spread and it is evident that the iron is without elasticity. Our cupola is 36 inches in diameter and we charge 780 pounds of coke on the bed, followed by 1,500 pounds of iron and the subsequent charges consist of 225 pounds of coke and 1,500 pounds of iron. Our average heat consists of 7,500 pounds of iron. The iron is not as hot as it should be, owing to the fact that it must be held for a considerable period before it is poured into the molds.

Answer.—The analysis of piston rings is approximately as follows: Silicon, 1.50 to 2.00 per cent; sulphur, under 0.08 per cent; phosphorus, 0.30 to 0.50 per cent; manganese, 0.50 to 0.60 per cent; combined carbon, 0.60 per cent, and the graphitic carbon should be approximately 3.50 per cent. You can make one charge of this hard iron and use it for the rings. The fact that the rings you are now making remain spread after being cut reflects the elasticity of the metal.

The Monarch Engineering & Mfg. Co., Baltimore, has purchased the American and foreign patent rights, patterns, drawings, etc., of the complete line of non-ferrous melting furnaces formerly built by the Rockwell Furnace Co., New York City. This includes also the patents and patterns for the pumps, blowers and other accessories used in connection with these furnaces.

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Trade Outlook

DECLINING pig iron quotations by no means reflect trade conditions in the foundry industry. Jobbing shops are crowded with work and production is curtailed as a result of the scarcity of skilled labor. Many steel foundries are unable to make deliveries in less than three months and users of malleable castings are experiencing great difficulty in placing orders for early shipment. Gray iron shops specializing in machinery castings report a continued steady tonnage, and from present indications all foundries will be actively engaged at capacity until the first of the year. Although there has been a slight lull in motor car construction, yet the builders are unable to obtain castings as speedily as they are required. Numerous contracts also are being placed for next season's casting needs by automobile and motor truck builders, and in every instance the tonnage specified far exceeds that placed last year. Brass and aluminum foundries likewise are engaged at capacity. No. 2 foundry iron quotations in the leading centers follow: Pittsburgh, $14.90 to $15.15; Cleveland, $14.75; Cincinnati, Ohio southern, $15.70 to $16.20; local, Chicago, $15.50 to $16; No. 2X Philadelphia, $16 to $16.50, and southern, Birmingham, $10.00 to $10.50. Malleable Bessemer is quoted at $15.15 to $15.40, Pittsburgh, and $15.50 to $16, Chicago. Lake Superior charcoal iron has declined to $16.75, Chicago. Basic iron is firm at $15.40, Pittsburgh, and $15.75, Philadelphia.

Steel Casting Production

IN 1912, the total production of steel castings in the United States, from figures compiled by the American Iron and Steel Institute, was 966,621 tons, as compared with 646,627 tons the previous year, a gain of 319,994 tons. Of this total, 90.1 per cent were made by the open-hearth process, as compared with 88.3 per cent in 1911. This indicates that open-hearth practice is making more rapid strides than the other methods, although in this connection it should be stated that the capacity of open-hearth plants in almost every instance greatly exceeds that of Bessemer or crucible steel works. Approximately 7.1 per cent were made by the standard Bessemer process or some of its modifications, as compared with about 8.8 per cent in 1911, and 2.8 per cent were made by the crucible, electric and minor processes, as compared with 2.9 per cent the previous year. This indicates that notwithstanding the additional tonnage produced by the numerous side-blow converters installed during the past year the proportion of output was unchanged because of the big increase in the open-hearth steel tonnage. There were produced in 1912, 68,750 tons by the Bessemer process or some of its modifications, as against 57,101 tons in 1911. Open-hearth plants produced 870,848 tons, as compared with 571,191 tons the previous year, and the production of crucible steel castings and all other processes aggregated 27,023 tons, against 18,335 tons in 1911. The open-hearth process since 1898 has shown a remarkable growth. In that year, there were produced 120,587 tons, and the output increased rapidly until in 1907, when 746,525 tons of open-hearth steel castings were made. In 1908, however, there was a sharp decline, the total tonnage having aggregated

only 311,777 tons, but in 1910, this was increased to 863,351 tons; 1911 again was a lean year and the production declined to 571,191 tons. Proportionately as great has been the increase in the production of Bessemer steel castings, the total in 1898 having aggregated 3,539 tons, and there has been a steady increase in the output, the most rapid advance having been made in the last three years. The production of crucible steel castings has varied considerably since 1898, when 7,811 tons were produced. In 1907, this total had been increased to 23,319 tons, but in 1908, another lean year, the production declined to 13,884 tons. The following year, however, there was a sharp increase, the total output having aggregated 21,388 tons, and 1912 compared with 1911 shows an increase of nearly 9,000 tons. In 1898, the total production of steel castings was 131,937 tons, and until 1912, the banner year was 1910, with a total of 940,832 tons. Last year 222 foundries in 28 states, the District of Columbia and the Canal Zone, Panama, manufactured steel castings, against 207 works in 27 states and the District of Columbia in 1911. The production of steel castings by the electric process last year aggregated 4,162 tons, and by various minor processes, 2,311 tons were made. Included in the total for 1912 are 103,109 tons of steel castings which were treated with ferro-vanadium, ferro-titanium, ferro-chrome, nickel, or other alloys, of which 18,814 tons were Bessemer, 80,685 tons open-hearth, 3,208 tons crucible, 392 tons electric, and about 10 tons were miscellaneous. The increase in the production of open-hearth castings in 1912 as compared with 1911 was 299,657 tons, or 52.4 per cent. The total production of all kinds of steel ingots and castings amounted to 31,251,303 tons, against 23,676,106 tons in 1911, an increase of 7,575,197 tons, or almost 32 per cent. The production last year was much the largest in the country's history, and the year of next largest output was 1910, when 26,094,919 tons were made. Of the total output in 1912, about 66.5 per cent were made by the open-hearth process, as compared with 65.9 per cent in 1911; about 33 per cent by the standard Bessemer process or some of its modifications, as compared with about 33.6 per cent in 1911, and about 0.5 per cent by the crucible, electric and minor processes, which showed practically no change in the percentage over the previous year.

Continuous Radiator Foundries

IN THE past few years, the radiator industry of the United States has undergone marked changes which are having a pronounced effect on the operating economy of certain types of radiator foundries. A large part of the demand at the present time is for low radiators, 24 inches or less in height, and the call for radiators in the 5-foot class has diminished accordingly. The foundries in this and other countries may be divided into two general groups, intermittent and continuous. The latter are designed for uninterrupted service, the molding, sand-handling, pouring, cooling, shaking-out and cleaning operations being controlled mechanically, while the former are equipped with molding machines of the stripping plate or roll-over type, which permit more or less flexibility in the output. The continuous plants are built to turn out a certain number of flasks per day and once constructed, the rate of production cannot be altered except within very narrow limits. Such foundries are at a disadvantage in making 24-inch radiators because their tonnage output under these conditions is only about one-half what it is when working on larger sizes and the cost per ton of finished castings is correspondingly higher. These circumstances have led one of the largest radiator manufacturers in the country to so arrange his orders that only 5-foot radiators are made in the continuous foundries, leaving the small work for the shops equipped with the ordinary types of molding machines.

Pennsylvania made 15,279,612 tons, or 50.4 per cent of the total production of steel ingots in 1912, against 11,736,329 tons, or 50.9 per cent, in 1911. Ohio was the next largest producer with a total of 6,696,072 tons, or 22.1 per cent, and Illinois followed with 2,671,882 tons, or 8.8 per cent.

Under the Hat

ARE you an *under-the-hat* foundryman? Ask yourself. Do you belong to that small coterie of casting manufacturers who believe—and by so believing ultimately convince themselves—that the greatest achievements in foundry work are circumscribed by their own operations and for that reason must be kept *sub rosa,* or in the vernacular of the street "strictly under the hat"? It is fortunate for the industry at large that the majority of foundrymen are willing and anxious to convey their knowledge to others, whether or not they are engaged in a competing line. To them must be credited a large measure of the advancement recorded in practice in the last two decades. They blazed the trail, and if their discoveries yielded gold-bearing ores, they unselfishly distributed the nuggets among their co-workers. To them the foundry industry is indebted too deeply to be repaid in any manner other than a reciprocal exchange on an equivalent basis. Unfortunately, many of the largest manufacturers of castings who have been the greatest beneficiaries of these research exploring expeditions, offer nothing in exchange and surround their operations with the utmost secrecy. They are returning to the dark days of foundry practice. They would have others grope in a nebulous atmosphere, believing that by so doing they can enjoy the fruits of some new methods and thereby defer the day of competition. Four of the so-called combines refuse foundrymen admittance to their plants and if an employe divulges the secrets of their practice, the penalty is discharge. These methods place a premium on dishonesty and in addition, they are by no means in accord with the spirit of this progressive age. Foundrymen engaged in big operations should lead in the dissemination of information relating to their practice. They have been and are the greatest beneficaries of the investigations made by foundry chemists, metallurgists and engineers and their debt to the industry should be repaid in kind. None can long confine the knowledge of his operations under *one hat* and the rapidity of the dissemination of this information is in direct proportion to the value of the discovery and the practice. This is an era of publicity and this applies to foundry work equally as much as to our daily affairs.

Equipment for the Foundry and Pattern Shop

Description of an Improved Roller-Ramming Molding Machine—A Novel Crane Grinder—Multi-Stage Blower

TO PRODUCE by machine molding methods a special lot of castings of rather unusual size and outline, a new type of the MacDonald roller ramming molding machine recently was developed at the plant of the Snead & Co. Iron Works, Jersey City, N. J. This machine is adapted to deep flask molding and to the diversified class of work common to the jobbing shop. The particular work for the accommodation of which the capacity of the new roller machine was built, consisted of a number of iron flasks for use in soil pipe plants. These flasks were 6 feet, 2 inches long, 32 inches wide and 5½ inches deep and were made for the production of four 4-inch soil pipe molds in one flask. Owing to their size and depth, they could not be molded upon the grooved roller machine now in use in this shop, which has a capacity for flasks up to 30 inches wide. While the machine was developed to meet the needs of a particular job, it represents a new general design of the MacDonald type which has great possibilities for handling wide and deep flasks in jobbing shops.

The flask in which the molds were rammed was 10 feet long, 42 inches wide and the cope and drag halves were each 9 inches deep. The machine, however, has a capacity for taking flasks up to 18 inches deep. In Fig. 1 is shown the pattern for the soil pipe flask supported on the follow-board of the machine and the flask being lowered over it.

The Sand Frame

The metal frame which serves as the retainer for the sand, is then placed in position above the flask. The frame is composed of 4-inch angles in the machine described, although it may be made larger in accordance with the depth of the flask. It fits upon both the sides and the ends of the flask, I-beam tracks are provided for the roller, which are hinged at one side of the machine so as to enable them to be lifted out of the way when the flasks are to be placed in position or removed. Springs are provided to counterbalance the weight of these tracks and to enable one operator to readily handle them.

After the flask and the sand frame are filled with sand, a large, flexible wood pad which practically covers the full area of the flask is placed upon the sand frame. This pad consists of 2 x 4-inch oak blocks bound together with steel cables. The lower side of the pad is cut out to conform to the lines of the pattern, which, with the flexibility of its construction, contributes toward the uniform ramming of the mold, in that the depth of sand is regulated over all the contact parts of the pattern and every part receives proper pressure. This is of importance in protecting the mold against damage when the pattern is withdrawn. This accommodation of the under lines of the pad to the shape of the pattern makes unnecessary the use of strike-offs which work the sand before the roll in the former machine. When the pad is in position, it projects about 4 inches above the top of the sand frame. A bridge bar is hooked into the last

FIG. 1—FLASK BEING LOWERED OVER PATTERN WHICH IS MOUNTED ON A FOLLOW-BOARD

FIG. 2—FLASK AND FRAME FILLED WITH SAND AND FLEXIBLE PAD BEING LOWERED INTO POSITION

member of the pad to hold it in position. The pad holds the sand intact and communicates downwardly the force of the ramming movement, and at the same time it prevents the sand from being pushed forward under the impact of the roll. In Fig. 2 are shown the flask and sand frame in place and filled with sand. The flexible pad is being lowered and placed upon the sand in the sand frame.

The roller then passes over the pad several times, forcing the latter downward into the sand frame and ramming the sand in the flask. This operation is shown in Fig. 3. It will be noted, however, that the pad does not enter the flask. The roll is propelled over the pad by a long arm made of riveted steel channels which is similar to that used on the MacDonald grooved roller and pattern-drawing machine and is driven by spur gearing. All the driving mechanism is under lever control. There is no back gear as in the former machine and the motor, reducing gear and other driving parts are carried on one line. The mechanism is mounted on a large base casting. All the driving parts run in oil and are enclosed, thereby reducing the possibility of injury to the workmen. The roll is not grooved, as in the former machine, but has flanged ends which fit over the I-beam track. In the former machine, the grooves in the roll fitted over the lateral members of the angle frame and the latter acted as a retainer for the sand as well as the track.

FIG. 3—ROLLER PASSING OVER PAD, PUSHING IT INTO THE SAND FRAME, THEREBY RAMMING THE MOLD

FIG. 4—FIVE OF THE DRAGS READY FOR THE COPES

The width of the track regulated the width of the flask that could be rammed upon this machine. Formerly, the tracks were hinged to the rear of the machine, requiring a high head room when they were raised after the ramming, preparatory to the drawing of the pattern. The head room in this case was fixed. In the new machine, the tracks are hinged at the side. This limits the head room required to a height convenient for the workman to move about. In Fig. 1, the hinged track has been swung off the machine.

After the mold has been rammed, the pad and sand frame are removed from the flask and the track is swung aside; a bottom-board is clamped on and the flask is rolled over. The pattern is drawn by hand. In Fig. 4 are shown five finished drags. No bars are used in the drag flasks. The copes are rammed similar to the drags. Fig. 5 shows the finished castings after having been sand-blasted.

Quigley Furnace Purchase

The good will, drawings, patterns, patents, etc., of the Rockwell Furnace Co., New York City, have been purchased by the Quigley Furnace & Foundry Co., Springfield, Mass. The latter concern will continue the manufacture of the full line of Rockwell furnaces with the exception of the melting furnaces, portable heaters, rivet forges, etc., which will be built by the Monarch Engineering & Mfg. Co., Baltimore.

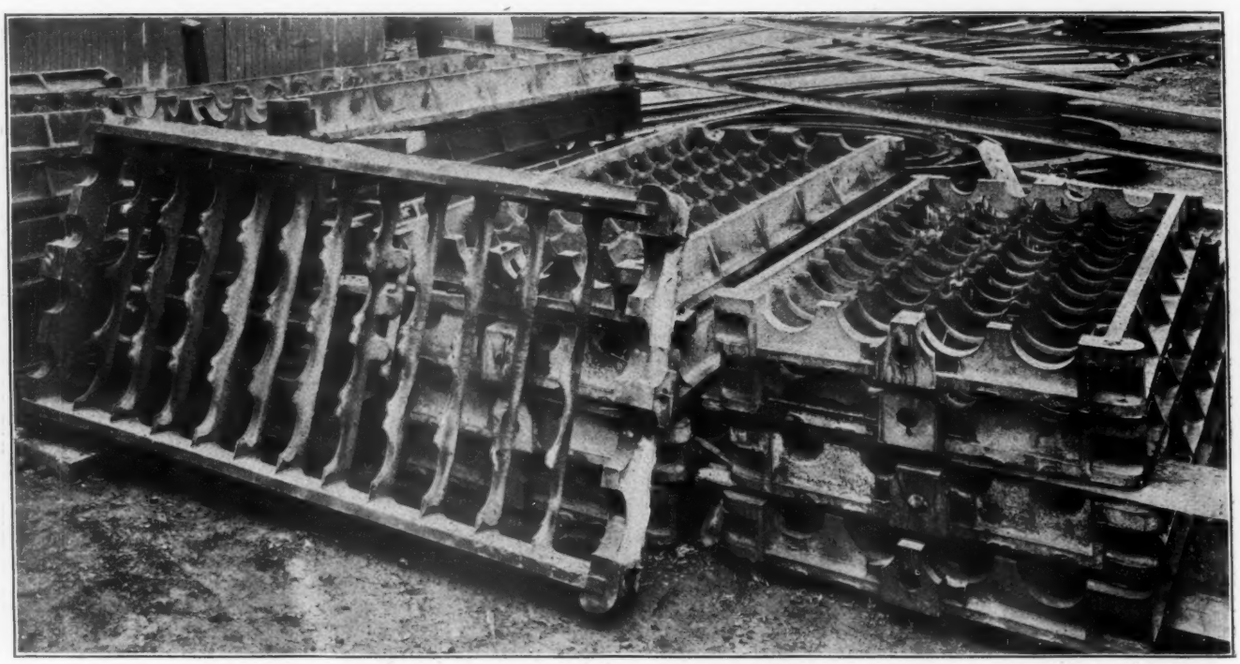


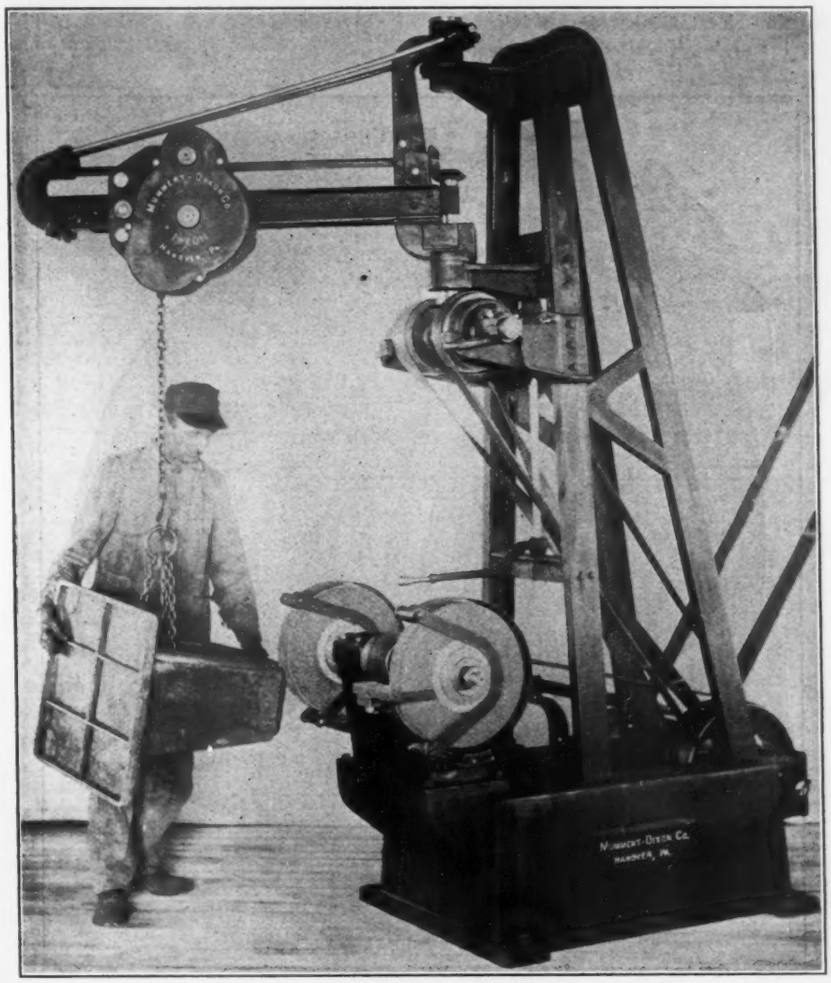
FIG. 5—THE FINISHED FLASK CASTINGS

A Novel Crane Grinder

To falicitate the grinding of large castings which cannot be handled in the ordinary way, the Mummert-Dixon Co., Hanover, Pa., has designed a special machine which is shown in the accompanying illustration. It consists of a grinding stand combined with a power jib crane. When grinding castings which are too heavy to be lifted by hand, the crane is used to support them at the proper height and at the proper distance from the grinding wheel. The operator only is required to swing them against the wheel and his work is greatly facilitated, as he is not encumbered by the weight of the casting.

The hoist is power-operated and its raising and lowering is controlled by a lever conveniently located. The casting can be swung in any position horizontally and can be suspended at any height vertically. Provisions also are made for operating the hoist by hand by means of a crank which slips on the end of the clutch shaft. The hoist trolley, which is mounted on the jib, is driven by a square shaft operated through bevel gears from the clutch pulleys mounted on the shaft supported by a bracket attached to the frames. The clutch pulleys, one for hoisting and the other for lowering, are driven by belts from the countershaft at the back of the machine. The hand lever controls both clutches and moving it in one direction engages the lifting clutch and in the opposite direction, the lowering clutch. The central position is neutral. The trolley follows in or out on the jib as the operator moves the casting. The swinging jib also follows the casting and this, with the flexibility of the chain, enables the operator to manipulate the casting as required.

The emery wheel stand is mounted at the front of the heavy base of the machine and as it overhangs, it provides sufficient clearance in front of the tool and under the wheels A detachable rest is provided which may be used for lighter castings. To the back of the face are attached the two steel frames to which are fastened the brackets supporting the swinging arm of the jib crane.



THE MUMMERT-DIXON CRANE GRINDER

Influence of Metalloids on Cast Iron

At the annual meeting of the Iron and Steel Institute, held recently at London, Eng., H. I. Coe presented a paper on "The Influence of the Metalloids on the properties of Cast Iron." A large number of interesting experiments was made and the following conclusions were arrived at regarding the results of silicon, manganese, sulphur and phosphorus in cast iron:

Silicon decreases the strength and hardness of cast iron owing to its effect in promoting the decomposition of iron carbide.

Manganese, to the extent of 0.5 per cent, results in a considerable softening of siliceous gray irons, owing to its effect on the condition of the carbon; the strength is increased by the addition of manganese.

The influence of sulphur is largely determined by the percentage of silicon present. Carefully controlled, it should be of considerable value to the iron founder in mixing his irons for any particular purpose.

In the absence of manganese, and in the presence of about 2 per cent of silicon, very strong gray cast irons may be obtained if the percentage of sulphur be judiciously raised.

Phosphorus, to the extent of about 1 per cent, is useful, since it confers fluidity upon cast iron, slightly increases the strength, and also slightly diminishes the hardness of the metal. A higher percentage results, however, in a hard, brittle material.

Bennett-O'Connell Co.'s New Warehouses

The Bennett-O'Connell Co., Chicago, manufacturer of polishing and plating equipment and supplies, has established an eastern branch and warehouse at Springfield, Mass., in charge of Gus Creutz, formerly at the head of the Cleveland branch of this company. Mr. Creutz has been succeeded at Cleveland by A. L. Myer and a new office and warehouse has been established in the Euclid-Penn building, that city. At both the Springfield and Cleveland branches, a complete line of polishing and plating equipment and supplies is carried in stock

The Lake Superior Iron & Chemical Co., Detroit, has removed its offices from the Penobscot building to the Dime Savings Bank building.

The Lamb & Deyell Refining Co., Providence, R. I., recently has been organized and has purchased the refining business formerly operated by the Almy-Cory Co., of that city.

Foundry Elevator Guarding

In a recent issue of *The Review*, William H. Doolittle, safety inspector of the National Metal Trades Association, discussed "Foundry Elevator Guarding" in part as follows:

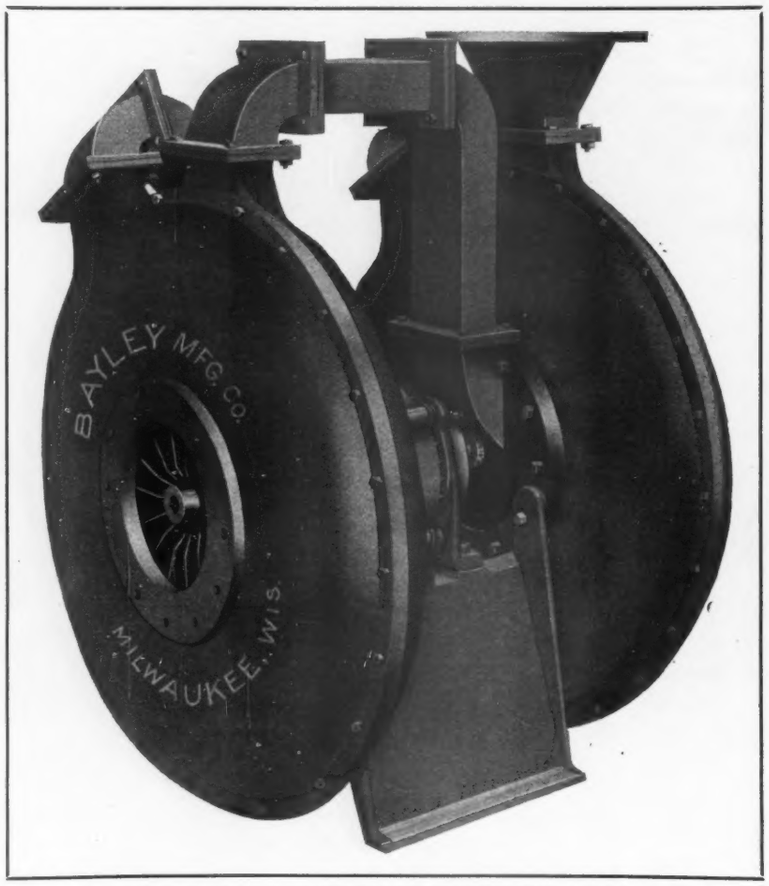
"In all foundries where the cupola charging floor is above the level of the yard it is necessary to provide some means of getting iron, coke and other materials up to the charging floor. The device used most commonly for this purpose is the elevator. The material is loaded on trucks or barrows, run onto the elevator platform at the yard level and by it raised to the required height. The elevator is usually operated by the laborer who brings to the cupola the load of material.

"There is considerable danger of these unskilled workmen being injured by the elevator and very careful guarding is desirable.

"There should be strong gates at both floors which should be automatic in action and maintained in perfect working condition. No workman should ever be allowed to fasten either gate in its high position, since by doing so the entrance to the elevator shaft is left unprotected and some one may enter it and be injured. The lower gate should either be so high that a man may not put his head over it or so low that in event of his doing so he will not be caught by the descending platform. The upper gate should be extended to the floor, preventing material dropping from the charging platform on the heads of workmen below. If there is not sufficient movement to the gate to allow this being done a heavy wire screen may be installed which covers the cage and protects men who are riding from falling material.

"If the elevator is lifted by cables there should be upper and lower limit stops attached to the mechanism independent of those on the operating rope and they should be frequently inspected and carefully adjusted. The safety gripping device should be kept in perfect order so that it will act instantly in case of the breakage of the cables or failure of the hoisting machinery. Counterweights, if in the elevator shaft, should be enclosed and that part of the platform adjacent to the counterweight screened. The lower sides of floor joists, beams and all other projections in the elevator shaft should be beveled or slanted so that material or men may not be caught between these projections and the platform of the elevator. The slant should be long and gradual.

"It is dangerous to raise truck loads of material on a foundry elevator without making provision against their rolling off. The wheels should be blocked by sprags or dogs, or some other method used to prevent accidents from this source."



BAYLEY MULTI-STAGE BLOWER SHOWING INLET FAN

New Multi-Stage Blower

A multi-stage fan blower for cupolas, air furnaces and other foundry purposes has recently been developed by the Bayley Mfg. Co., Milwaukee. Its details are shown in the accompanying illustration. There are two fan cases mounted on a cast iron base with a direct-connected constant speed induction motor between. The fan cases are divided into two parts by a central diaphragm. The blower illustrated, therefore, has four stages, each delivering a pressure of 8 ounces with a peripheral speed of 14,000 feet per minute. The total pressure delivered at the final stage is two pounds. Additional stages may be added if higher pressure is required. The 31-inch blower operates at 720 revolutions per minute.

It is claimed that the blower delivers a constant flow of air without pulsation and that it is noiseless in operation. It is also designed so that it will build up pressure above the normal if a resistance such as clogged tuyeres is encountered. This type of blower has also been used as a gas booster, for agitating heavy liquids and in connection with oil burning apparatus.

Bronze Test Pieces

In the June number of THE FOUNDRY, page 224, an article was published entitled "Making a Large Vanadium Bronze Engine Housing." It referred to the practice of the Vanadium Metals Co., Groton, Conn., and the statement was made therein that four test lugs are cast in chills inserted in the drag half of the mold. This is incorrect, as the use of chills on test pieces is absolutely forbidden on government work, as the test pieces are placed on the casting where required by the inspectors and are cast so as to be as nearly representative of the casting itself as it is possible to make them.

The Detroit Platers' Supply Co., 310 Hammond building, Detroit, has been organized to continue the business of D. B. Moyer. D. W. Moyer is secretary and manager, and F. W. Page is president and treasurer of the new company.

Death of Dr. E. E. Brown

Dr. Elmer E. Brown, head of the firm of E. E. Brown & Co., Philadelphia, manufacturers of sash weights, and who was prominently identified with the foundry and business interests of Philadelphia, died in that city May 23, at the age of 53. In 1881 Dr. Brown was employed by Hoopes & Townsend and later was affiliated with the Armbruster Sash Weight Co. At the age of 25 he started in business for himself and organized the firm of E. E. Brown & Co. Dr. Brown was vice president of Temple University, vice president of the Philadelphia Foundrymen's Association, president of the Buchanan Foundry Co., Lebanon, Pa., a director of the Waterbury Foundry Co., Waterbury, Conn., and president of the National Sash Weight Association. He also was a director of several fire insurance companies and of the Quaker City National Bank. As he always desired to become a physician, at the age of 36 he entered Jefferson Medical College, from which he was graduated in 1897. He is survived by a widow and two sons, Clarence, who is a member of the firm of E. E. Brown & Co., and Harold, who is in charge of the Buchanan Foundry Co., at Lebanon.

Personal

JOHN S. BANKS has been appointed general foreman of the foundry operated by the National Transit Co., Oil City, Pa.

J. W. PATTERSON, formerly of Newcastle, Pa., has been appointed superintendent of the foundry of the Dominion Bronze Mfg. Co., Preston, Ont.

W. J. Allen, foreman plater of the Clayton & Lambert Co., Detroit, is now affiliated with the Keeler Brass Co., Grand Rapids, Mich.

CONRAD J. FIX who has been affiliated with the Northwestern Malleable Iron Co., Milwaukee, during the past 30 years, has taken charge of the core department of the malleable iron plant of the Chain-Belt Co., of that city.

H. M. FOOTE, formerly in charge of the steel casting department of the Wellman-Seaver-Morgan Co., Cleveland, has been appointed general manager of the Atlas Steel Foundry Co., of that city. This plant formerly was known as the Ohio Crucible Steel Co.

Foundry Exhibit Prospectus

The Foundry & Machine Exhibition Co., under whose auspices the exhibition of foundry equipment and supplies, machine tools, etc., will be conducted in Chicago concurrent with the foundrymen's conventions, Oct. 10 to 17, has issued a handsomely illustrated prospectus directing attention to the facilities of the International Amphitheatre, where this year's exhibition will be held. Numerous views are included, showing the exhibits at Pittsburgh and Buffalo, with a floor plan of the International Amphitheatre. The complete list of the 1912 registration also is included, which contains the names of the foundry foremen, superintendents and other shop executives who attended this show.

DR. ELMER E. BROWN

Hill-Brunner Foundry Supply Co.

The Hill-Brunner Foundry Supply Co., Cincinnati, has been organized by John Hill, formerly president of the Hill & Griffith Co., of that city, and Fred J. Brunner, who was associated with the S. Obermayer Co. during the past 15 years. A plant has been established for the manufacture of graphite, plumbago and foundry facings, core compounds and a general line of foundry supplies and equipment. Branches have been established at Chattanooga, Tenn., and Birmingham, Ala.

Hermann Gehnrich, builder of portable core, japanning, enameling and lacquering ovens, has removed his plant to the new building recently created on Franklin avenue, Brooklyn. A large amount of new equipment has been installed and the capacity has been considerably increased.

Convention Committee Named

CHARLES A. PLAMONDON, chairman of the general committee in charge of arrangements for the foundry convention, which will be held in Chicago, Oct. 10 to 17, has appointed the officers and members who will assist him and has also appointed the chairmen for the various sub-committees.

David R. Forgan, president of the National City Bank, Chicago, will act as treasurer, and H. Cole Estep, associate editor of THE FOUNDRY, has been appointed secretary of the general committee. The finance committee will be headed by J. A. Galligan, in charge of the coke sales department of Pickands, Brown & Co.; William Francis, of Francis & Nygren Foundry Co., will be chairman of the reception committee, and James Wood, president of the Sheffield Foundry Co., will head the entertainment committee. The publicity work for the convention will be in charge of O. J. Abell, western editor of *The Iron Age*, who has been appointed chairman of the publicity committee.

A pre-convention round-up and beefsteak dinner was held by the Chicago Foundrymen's Club at the Stock Yards Inn, Forty-second and Halsted streets, on Saturday evening, June 7. This location was chosen in order that the diners might become familiar with the building in which the exhibition of foundry supplies and equipment will be held next October. The meal was served in the beautiful arched main dining room of the Inn and about 100 sat at the round tables. The program was largely musical. Mr. Plamondon, who was unable to be present, sent a letter in regard to convention matters, which was read by James Wood, president of the Foundrymen's Club, who acted as toastmaster. Other aspects of the convention were discussed in brief remarks by C. E. Hoyt, secretary of the Foundry & Machine Exhibition Co., O. J. Abell and H. Cole Estep.

Mr. Hoyt stated that already 50,000 square feet of floor space has been sold for the exhibition, more than half of all that is available. This is nearly as much as the combined space at the Pittsburgh and Buffalo shows. Present reservations make it certain that the exhibits will cover not only the usual array of foundry supplies and equipment, but practically everything in the way of machinery used in the iron and steel industry from heavy boring mills to recording thermometers.

No attempts have been made to estimate the attendance at the Chicago convention, but on account of the central location of the city, its unsurpassed railway facilities and the large number of foundries as well as other iron, steel and metal working plants within its environs, it is expected that all previous records will be surpassed.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Star Brass Co., Kalamazoo, Mich., is building a new foundry, 80 x 111 feet.

The Phoenix Foundry Co., Phoenix, Ariz., is operating its new plant. Gray iron and brass castings are manufactured.

The City Foundry Co., East Providence, R. I., recently completed a new shop, 75 x 100 feet, which is equipped for the manufacture of gray iron and brass castings.

The Manufacturers Foundry Co., Waterbury, Conn., manufacturer of gray iron castings, has increased its capital stock from $100,000 to $200,000.

The Dominion Bronze Mfg. Co., Preston, Ont., will erect a new foundry. J. W. Patterson, formerly of Newcastle, Pa., is the superintendent.

The Manitoba Bridge & Iron Works, Winnipeg, Man., recently has completed a foundry building, 60 x 178 feet, which is to be used as a jobbing shop.

The Clark-Banks Foundry Co., Buffalo, has been incorporated by S. L. Clark, M. A. Banks and G. L. Banks, with a capital of $10,000. K. V. Clark is manager.

The Alloy Steel Casting Co., Wheeling, W. Va., has been reorganized and the firm name changed to the Wheeling Steel Castings Co. The plant will be enlarged.

The Narragansett Foundry Co. has been organized at Providence, R. I., by John A. Petersen and G. Quanstrom. A shop, 52 x 70 feet, has been built, which is equipped for the manufacture of gray iron castings.

The Lewis Foundry Co., West Toledo, O., which has operated a gray iron shop for some time, recently was incorporated. The plant is well equipped throughout and considerable new machinery is being installed.

New Construction

The Gartshore-Thomas Pipe & Foundry Co., Hamilton, Ont., is building a $5,000 addition to its plant.

The Ellwood Foundry, Ellwood City, Pa., is building an addition for offices and pattern storage.

The Frank Stary & Sons Foundry, Cedar Rapids, Iowa, will build an addition to its plant.

The Seattle Frog & Switch Co., Seattle, contemplates the erection of a gray iron foundry.

The Hallet Iron Works, Chicago, will build a foundry, 60 x 162 feet, at Harvey, Ill. The building and equipment will cost about $15 000.

The Bowdry & McKinley Iron Foundry, Fort Worth, Texas, will move from South Hemphill street to the north side of the city and will build a larger plant.

The Blower Co., Bucyrus, O., has purchased the Shunk Foundry and will build a $24,000 addition. Considerable equipment will be required.

The Federal Metal Co., Cleveland, will erect a brass foundry on property recently purchased on Morgan avenue S. E. Bids for the building and equipment are being received.

The Lumen Bearing Co., West Toronto, Ont., Can., will erect an extensive addition to its plant, which will be devoted to the manufacture of trolley wheels, die-castings and sand cast brass and bronze castings.

The Brillion Iron Works, manufacturer of crushers and gasoline engines, Brillion, Wis., will build an addition to its foundry, 60 x 120 feet. The building will be constructed of steel and concrete and will be equipped with overhead trolleys and overhead pouring system, tracks, cranes, and molding machines. An addition to the warehouse will also be erected.

The Wayne Brass Foundry Co., Pittsburgh, is now located in its plant on Butler street between Forty-sixth and Forty-seventh streets. About six years ago this company commenced operations in a plant on Home street, but owing to the rapid increase in its business, the new plant was erected, which more than doubles the previous output of brass and aluminum castings.

The Barlow Foundry Co., Newark, N. J., will build three one-story buildings to cost approximately $50,000. A malleable iron foundry, 70 x 280 feet, a gray iron foundry, 60 x 180 feet and a connecting building, 100 x 200 feet for offices, pattern shop, core room, etc., will be erected. The buildings are to be of fire-proof construction and special consideration has been given to ventilation, lighting and general equipment.

The Spring City Foundry Co., Waukesha, Wis., has been organized with a capital stock of $10 000, by Casper Reichl, Albert Icke and Gustave Schmidt, all of Milwaukee. Part of the former car shops of the Wisconsin Central railway has been leased and foundry equipment will be installed. The Werra Aluminum Co. also is located in this building.

Edward R. Caldwell, president of the Caldwell & Ward Brass Co., Syracuse, N. Y., has disposed of his interest to Porter B. Ward. Mr. Caldwell will organize a new company with his son, R. L. Caldwell, the firm to be known as E. R. Caldwell & Son. A plant immediately will be erected for the manufacture of brass castings. The Caldwell & Ward Brass Co. has operated a brass foundry for 18 years and will continue as heretofore.

The Gerline-Myers Brass Foundry Co., Kalamazoo, Mich., has been organized with a capital of $20,000 to engage in the manufacture of brass, bronze and aluminum castings. The foundry is 60 x 100 feet and the building for the storage of sand, etc., is 22 x 60 feet. Twelve coke-fired metling furnaces are being installed, as well as a number of molding machines, sand blast equipment, etc. The officers of the company follow: Samuel Franklin, president; Otto Gerline, vice president and manager, and Samuel B. Myers, secretary and treasurer.

The Swedish Crucible Steel Co., Detroit, is erecting a new plant at Windsor, Ont., Can. The first group of buildings will consist of a steel foundry, 100 x 125 feet and an administration building, 100 x 45 feet. The buildings are to be a steel and reinforced concrete construction, with temporary ends to permit of future expansion. The plant will be equipped for the manufacture of crucible steel castings and the Canadian company will be incorporated with a capital of $100,000, all of which has been subscribed by the stockholders of the Detroit company.

NEW TRADE PUBLICATIONS

AIR COMPRESSORS.—The Clayton Air Compressor Works of the International Steam Pump Co., New York, has issued a catalog in Spanish which is devoted to its extensive line of air compressors and accessories.

PNEUMATIC TOOLS.—A 48-page bulletin, issued by the Chicago Pneumatic Tool Co., Chicago, is devoted to this company's line of air-operated drills, reamers, wood borers, flue rolling and tapping machines and grinders. The bulletin is well-illustrated and contains details of the construction and operation of these various tools.

RELIEF VALVE.—In a four-page bulletin issued by the Connersville Blower Co., Connersville, Ind., a new type of none-vibrating relief valve is illustrated and described. This valve is intended for blower service and is absolutely free from vibration. The valve can be placed anywhere in the air line, preferably near the blower, and is connected into the line by a short nipple of standard iron pipe size. It can be adjusted to maintain any desired pressure between eight ounces and two pounds. It is built in two sizes, 1½ and 2½ inches, although any special size will be made.

AIR COMPRESSORS.—A 48-page bulletin, issued by the Chicago Pneumatic Tool Co, Chicago, is devoted to the complete compressor line manufactured by this company and treats particularly of general engineering information of value to users of compressed air. It contains tables giving efficiencies of air compression at different altitudes, density of gases and vapors, mean effective pressures and horsepower, loss of pressure due to friction in pipes, etc. Views of various types of compressors are shown in miniature, as well as illustrations of the interior of the Chicago Pneumatic Tool Co.'s compressor plant at Franklin, Pa.